South Cambridgeshire District Council:

a model for the 'sustainable' office

by **William Leddington-Hill**

12th September 2008

A Dissertation submitted in part fulfilment of the Master of Science Built Environment: Environmental Design and Engineering

Contents

Synopsis

Lauded in the architectural press as a 'sustainable exemplar', South Cambridgeshire District Council Offices is the product of a union between two polar opposite cultures: Local Government with a 'green agenda' and a Commercial Developer with the financial imperative of profit. Designed to embody the rigours of both cultures, South Cambridgeshire District Council could herald a new generation of affordable sustainable commercial offices.

In the literature review the need for 'low carbon' office design is established. Green office 'typology' is looked at for its traits and the definition of thermal comfort in an office is examined for its impact on energy consumption. The key lessons from the Probe studies are reviewed as a guide for the present study and the benchmarks and standards are established against which the success of the building can be measured.

The context of the building is described including: demand, location, design, procurement method, building, and building management; to explain building performance.

The building is evaluated using the Probe methodology of occupant questionnaires, energy assessment and air test, supplemented with meetings with the designers and facilities managers and sensor monitoring of key points in the building.

The assessment of the building draws together the strands of information and shows the importance of: procurement method, continuity in the design process, the need for mixed mode ventilation standards and a support and testing structure for the facilities management of the building.

In conclusion South Cambs is an object lesson in the importance of choosing the correct method of procuring a building, the need for mixed mode ventilation standards and the need for regulation of the energy use in buildings.

1.00 Introduction

It is stated in the United Kingdom Climate Impacts Programme (UKCIP) 08 report that:

"Warming of the global climate system is unequivocal, with global average temperatures having risen by nearly 0.8˚C since the late 19th century, and rising at about 0.2˚C /decade over the past 25 years". *[1]*

Scientists have now widely agreed that the increase in greenhouse gases from human activity could tip the planet into a global catastrophe, with rapid and destructive climate change. [2] In order to prevent this, carbon dioxide concentrations in the atmosphere need to be stabilised. [3] The UK Government has declared that climate change is the *"greatest long-term challenge"* facing the world today. Under the Climate Change Bill it will become a statutory duty to reduce carbon emissions by 60% by 2050 against a 1990 baseline. [4] Buildings will be central to the Governments target, as energy used by buildings accounts for 47% of the UK's carbon emissions. [5]

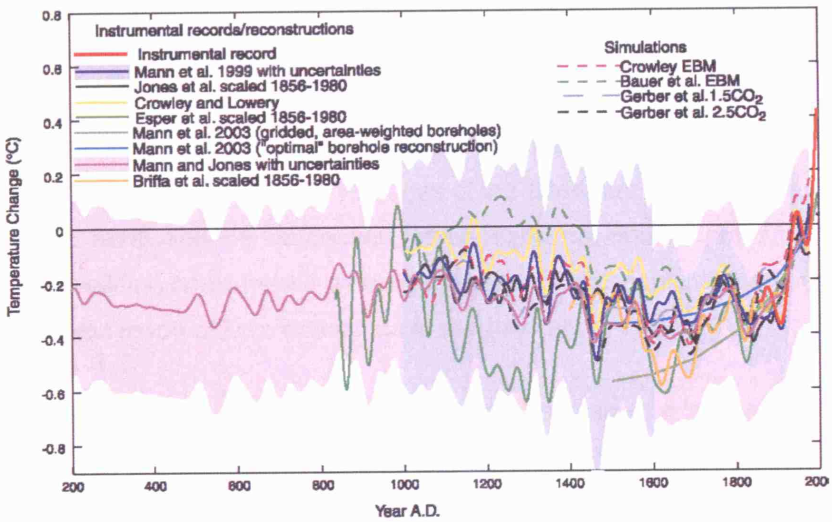


Fig 1. Hockey Stick Graph showing Carbon Emissions over the last 1800 years.

The climate change imperative in the UK is matched by the economic imperative to become a more efficient user of energy. The UK is becoming a net importer of gas and oil and is consequently exposed to the vagaries of the market price for energy and the uncertainty of supply from what are the more volatile areas of the world. These problems are exacerbated by the prediction of peak oil. [6]

The technical adaptive response to a warming climate will be the increasing use of air conditioning in buildings which is at odds with the Government's energy goals. The Carbon

Trust estimates that 40% of commercial floor space will be air conditioned by 2020, compared with only 10% at the end of 1994. [7] The cure-all to supplant energy-profligate air conditioning is seen as mixed mode ventilation a combination of predominantly natural ventilation fortified with the addition of mechanical ventilation. [8] Mixed mode ventilation has been piloted in various low energy buildings in the UK but unfortunately there is not nearly enough information on how they are actually performing in use. [9]

Using mixed mode ventilation allows temperature standards for thermal comfort to be relaxed. It has been found that on a seasonal basis a wider range of temperatures was acceptable in naturally ventilated offices by up to 2.5°C than in air conditioned offices. [10] This suggests a more flexible temperature control strategy could be adopted whilst retaining thermal comfort for the occupants and saving energy.

In commercial terms mixed mode buildings can offer the 'ideal' that Alex Gordon promoted 30 years ago as RIBA President of "long life, loose fit, low energy building" which can be easily altered to suit the needs of different occupiers and activities; a valid commercial model for profitable investment.

As a 'sustainable exemplar' South Cambridgeshire District Council (SCDC) is an amalgam of the commercial and the sustainable. [11] Previous 'sustainable exemplars' have been commissioned by Blue Chip companies well able to wear the risks inherent in cutting edge design whilst being aware of the advantages of the attendant publicity. It is the hybrid mixture of the 'ideal' and the 'hardnosed' which marks out South Cambs as a sustainable 'model'. The building could herald a new generation of affordable, low energy, naturally ventilated mixed mode offices well suited to our low carbon future.

The understanding of how SCDC works will be on the basis of a 'real world' research approach which allows for the complexities inherent in a working building. [12] The literature considered relevant to the study is enclosed, the context of the building explained, and the evaluation conducted with the Probe methodology supplemented with monitoring and modelling. From this information the study will analyse the performance of SCDC against: its prescribed aspirations and benchmarks of comparable buildings; and established standards with particular regard to its low energy performance and the thermal comfort of its occupants. The importance of the building integration of fabric, services and controls will be examined emphasising the importance of design, method of procurement and use by the management, to establish the validity of the building as a model for the future.

The objective of the whole exercise is feedback, gleaning valuable information from what is effect a living working experiment which can be fed into the design of future buildings and perhaps even improve the functioning of the actual building itself!

2.00 Literature Review

2.01 Climate Change

The Intergovernmental Panel on Climate Change, IPPC ARA-WG1, states that: *"It is very likely (>90% probability) that man-made greenhouse gas emissions caused most of the observed global average temperature **rise since the mid 20th century.**"* [13] The main culprit for global warming is carbon dioxide emissions from burning fossil fuels. [14] The current level of carbon dioxide is just over 380 parts per million by volume (ppmv) about 100ppmv above pre-industrial levels. [15] From 1970 to 2000, the concentration rose by about 1.5ppm each year, but since 2000 the annual rise has leapt to an average 2.1ppm. [16] Including other greenhouse gas sources, the total anthropogenic effect is estimated as equal to 430ppmv of carbon dioxide. [17]

In the past the accepted maximum safe limit was cited as 550ppmv as shown on the graph below but recent thinking has reduced the acceptable limit to 450ppmv. That means that global emissions must peak within the next ten years, and reduce at a rate of 5% a year in order to achieve by 2050 the 70% reduction that scientists estimate is needed. [18] This will need a step change in human behaviour.

In 1998 the United Kingdom Climate Impact Programme (UKCIP) started making quantitative assessments of the possible impacts of climate change. They have issued a series of UKCCIP scenarios which are based on the latest climate models and data. These scenarios are now used to assess the possible impacts of climate change on the UK. [19]

The UKCIP02 scenario has four predictions for greenhouse gas emissions based on information from the Intergovernmental Panel on Climate Change. [20] The predictions progress from intense use of fossil fuel to a more sustainable model with use of fossil fuel decreasing. Even with the low emission scenario B1 the atmospheric carbon dioxide continues to

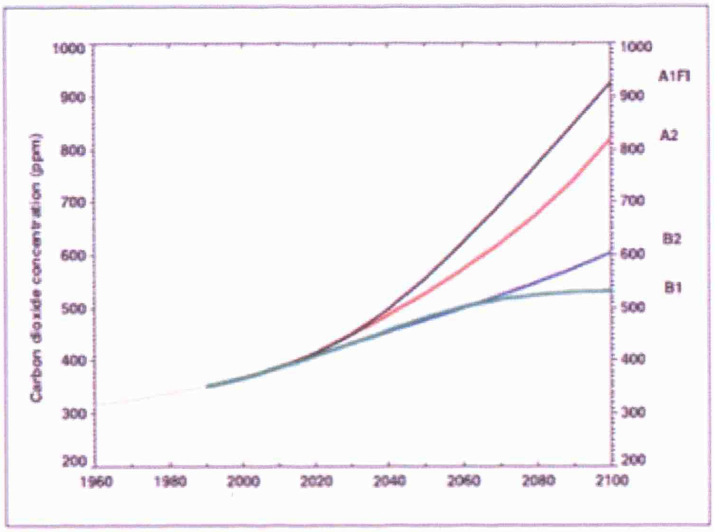


Fig 2. Global carbon dioxide concentrations from 1960 to 2100 for each of the four emission scenarios.

rise until of the middle of the century. So there is an inbuilt level of climate change over the course of the century which buildings will have to adapt to whatever measures are taken to reduce greenhouse gas emissions. [21]

Across the UK, climate change predictions suggest an average warming per decade varying between 0.1˚C to 0.3˚C for a low emissions scenario and 0.3˚C to 0.5˚C for a high emissions scenario. [22] To place these figures in perspective the maximum temperatures in London are projected to increase by between 3.6 and 6.9 K above the average seen from 1961-1990. [23] In short London by the latter part of this century will be enjoying the weather Marseille experiences today. The summers are expected to become dryer and milder and the winters wetter, combined with more extreme weather events such as heat-waves and periods of heavy rain. [24]

Not only does energy used by buildings directly account for 47% of the UK's carbon emissions. Indirectly construction, maintenance and building materials production adds a further 10% or more carbon emissions; and much of the UK's transport emissions, which account for a further 25% of the UK total, are for moving people and goods between buildings. [26]The energy performance of the built environment is critical to the Government's target in reducing carbon emissions. It is estimated that energy use by new and refurbished buildings could be reduced by up to 50% by today's standards. [25]

The anticipated change in the future climate will impact on the energy used by buildings. Building design will have to be 'futureproofed' to have the capacity to adapt to climate change. This will need to be reflected in future building design and refurbishment in form, material choice, thermal mass and building services. Climate change assessment will become increasingly important in addressing the future performance of new building design as well as the existing building stock. [26]

2.02 Generic Building Type

South Cambridgeshire is the latest incarnation of a developing building type which can be described as the extruded 'sustainable' office. The type first became apparent with the new Barclaycard Headquarters in Northampton by Fitzroy Robinson in 1997. The elements consist of:

- Shallow floor plates 15m wide for maximum daylight and cross-ventilation
- atria or glazed streets which serve as environmental and social spaces
- Use of atria for solar-assisted ventilation
- Stack-effect ventilation
- Orientation on east-west axis to give long north and south elevations
- Solar control by means of external blinds and building modelling
- Use of thermal capacity to dampen temperature swings
- Night-time cooling
- mixed mode displacement ventilation supported by air-conditioning in 'hot spots' [30]

The building type started in the 1990's with Gateway 2 at Basingstoke by Arup Associates, and other examples are Power Gen Headquarters by Bennett Associates and the Scottish Office at Leith by RMJM. [27]

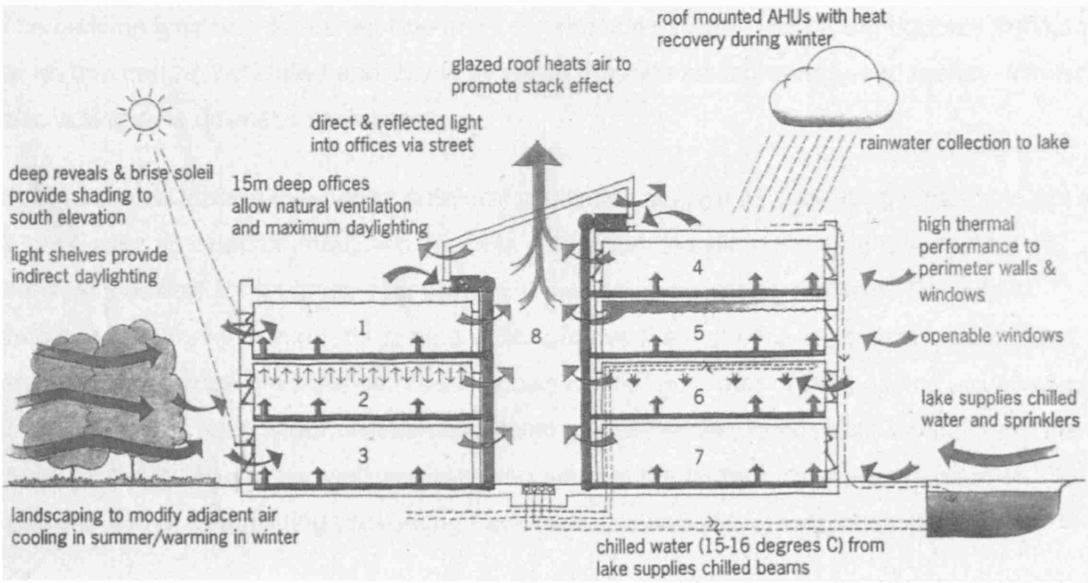


Fig 3. Environmental Section of Barclaycard Building Northampton, designed by Fitzroy Robinson and Partners

The development of the building type was prompted by the first oil shock of the 1970's which stimulated an interest in energy efficient design. The Guardian Newspaper in 1980 launched a competition to describe the community of the future. The winning entry 'buffer thinking' by Engineer Ralph Lebens and Architect Terry Farrell shows nearly all the key elements which have become apparent in the 'green' office morphology apart from the use of stack ventilation. [28]

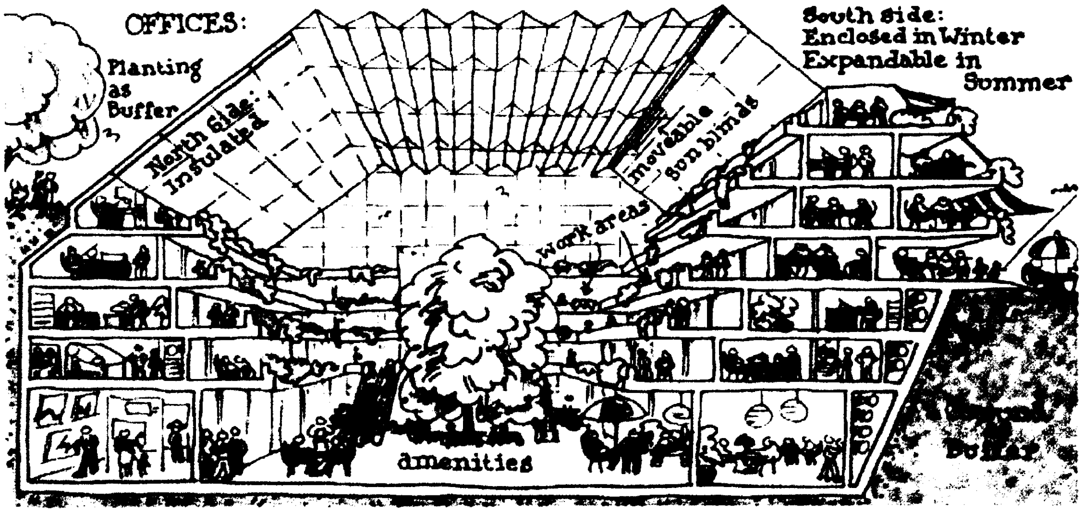


Fig 4. The sheltering Atrium from Terry Farrell and Ralph Lebens thesis 'Buffer Thinking'

The building type has flourished due to its commercial validity. The atrium doubles the plan width that can be ventilated and day lit by natural means saving energy and money. Whilst also acting as a dramatic social space.

For the central lantern to work as a natural ventilation system for a building it needs to act as a large solar assisted chimney. To promote ventilation, the air in the atrium should be as warm as possible for as great a proportion of the atrium height as possible. The rule of thumb is that the lantern needs to be one floor above the last floor to generate enough pull to draw the air through the building. The windows on the perimeter of the building are allowed to progressively open wider on each floor level up the building to equalise the pull from the lantern on each floor. The windows expelling air from the lantern must always open on the leeward side of the building preventing back pressure and aiding extraction. [29]

2.03 Thermal Comfort

The definition of a good indoor climate is crucial to the success of a building not only for the thermal comfort of its occupants but also for its energy consumption. It is a moot point how a good indoor climate is defined for a mixed mode ventilated building because at present no accepted standard exists. However there are good reasons to suggest that with mixed mode ventilation the thermal comfort of its occupants can be improved whilst also making large savings in energy consumption over air-conditioned systems used in buildings.

The indoor temperature of air-conditioned buildings is narrowly defined to a bandwidth of 22 ± 2°C. A steady state thermal comfort standard is set defined by BS EN ISO 7730 or ASHRAE 55-92. This is based on assumptions about occupants' clothing insulation and metabolic rate to arrive a fixed value which can be confirmed by a Predicted Mean Vote (PMV) to establish the most acceptable temperature for the largest population in a building. The only method of reaching this tightly defined set point value is by energy expensive air-conditioning. [30]

The most telling criticism of the steady state approach to thermal comfort is that at any one time only 50% of the population will be comfortable without adjusting their clothing. [31] The heat balance approach is unduly normative and unitary. Humans need a thermal experience beyond the normal comfort boundaries for a sense of well-being; variation is an element of comfort. [32]

In the early 1970's Nicol and Humphreys challenged the 'steady-state' comfort theory with the 'adaptive' comfort theory. In short this theory stated that if the building's occupants were allowed to adapt to their environment, by adjusting clothing. controls, or location, then they would tolerate environmental conditions outside those recommended by the current thermal comfort standards. [33]

The 'adaptive' comfort theory has been substantiated by the Probe building evaluation studies. Leaman and Bordass have demonstrated that there is more forgiveness of buildings in which occupants have more access to building controls; an adaptive opportunity which responded rapidly. If the control is left to the building manager there is a smaller envelope of acceptable conditions, comfort changes more quickly with temperature and the occupants appear less tolerant. [34] It was found that the acceptable range of temperatures in naturally ventilated offices in winter and summer was wider than air conditioned offices by 2.5°C. So a larger proportion of the population at any one time should be thermally comfortable in a naturally ventilated building, if the occupants have some control over their immediate environment, than an air-conditioned building. Overall Leaman and Bordass concluded that there was a preference for buildings with natural ventilation combined with summer cooling.

[36] Both CIBSE and ASHRAE are revising their standards in response to these observations to allow for a wider temperature in buildings which are naturally ventilated. [35]

In 1978, Humphreys developed the 'adaptive' theory by suggesting that the optimum internal temperature for an air-conditioned building could be related to the external temperature. An adaptive control algorithm (ACA) was developed to provide building designers with a simple method of controlling internal temperature. This was trialled in a building in Sweden and in the UK. The results with the ACA control against the original control showed little change in thermal comfort levels despite the higher internal temperatures. This suggests that internal temperatures can vary more than those set by the current thermal comfort standards set in buildings. [36] This may in some cases negate the need for air-conditioning at all. The extent of the energy savings for cooling has been estimated to be in the region of 10% in the UK and in a recent European project 18%. [37]

So a future sustainable standard for mixed mode ventilated building needs to combine natural and air-conditioning standards. Whilst in cooling mode the internal temperature should be defined in relationship to the external temperature. In natural ventilation mode the occupants should have control over their immediate thermal environment within the context of a generally acceptable environment which is more variable than present standards allow.

2.04 Post Occupational Evaluation

Essentially Post Occupational Evaluation has a simple purpose - to provide feedback from a building design. The importance of this information cannot be overstated the construction industry has a well deserved reputation for failing to deliver buildings that perform as intended. Feedback is needed to pinpoint the causes of these failures. Placed in the public domain designers can be informed of both the successes and failures of the past, so successes can be repeated and failures discarded, creating what Bill Bordass elegantly coined "as a virtuous circle of continuous improvement". Key performance indicators (KPI) or benchmarks are derived from POEs to provide a data base to measure future buildings performance. Feedback is also needed for building use. It is not unknown for a mismatch to occur between the building's intended use by the designer and actual use by the user. Feedback can be used to highlight and resolve these problems. [38]

The seminal work on building evaluation was done by Probe. Instigated to investigate the gulf between the predicted Computer simulated energy consumption and the actual building consumption. The Post-occupancy Review of Building and their Engineering (Probe) was published in the Building Services Journal over 10 years. Probe is the most substantial data base of information and analysis of buildings. [39]

There is a bewildering array of POE techniques, hence the UBT matrix.

UBT Feedback Portfolio: Techniques

This page: Sector [Where used in life cycle] [Development, Publication and Practical Details] .

	Defence	Education		Health	Offices		Leisure	Housing	Other
	Defence	Higher education	Schools	Health	Public sector	Private sector	Sports	Housing	Other

Showing: All [Facilitated_discussions] [Packages_of_techniques] [Process_improvement] [Questionnaires_and_interviews] [Sustainability] [Technical_assessment] .

	Defence	Higher education	Schools	Health	Public sector	Private sector	Sports	Housing	Other
AMA Workware Toolkit					Y	Y			
ASTM Standards									Generic
BCO POE Method									
BRE Design Quality Method	To some extent	To some extent	Y	Y	Y		To some extent		
BRE Toolkit									
BREEAM	Possible	Y	Y	Partial	Y	Y	Y	Y	Y
BREEAM Schools			Y						
BUS Occupant Survey	Partial	Y	Y	Partial	Y	Y	N	Partial	Possible
CIBSE TM22 energy survey	N	Y	Y	Y	Y	Y			
CIC DQIs	Partial	Y	Y		Y	Y			
DEEP	Y								
DQI for Schools			Y						
Healthcare Design Quality				Y				Possibly ..	
HEDQF POE Forum		Y	Tested	Tested					

Fig 5. Useable Building Trust Post Occupational Evaluation Methods Matrix.

The ideal POE techniques should:

Work well, be applied quickly and efficiently
Be reliable
Not be intrusive
Be relevant
Provide results can be compared with other buildings
Be economical to apply
Not rely on measured data [40]

Lessons from Probe

The Probe building evaluations highlighted a series of salutary lessons with building design and use which can act both as a pointer to any POE analysis and as a guide to any building designer in what to avoid:

- "Buildings are more like ships than cars". Each building is unique and needs working up like a ship with 'sea trials' to iron out its inherent problems before it performs efficiently.
- "Don't procure what you can't afford to manage". Do not design a building which is beyond the occupying organisation's capacity to manage. The consequences of this can emerge as staff dissatisfaction or wasting energy.
- "Keep it simple do it well". A key reason why buildings did not prove to work well in the Probe building analysis was their unmanageable complexity.
- The Probe POEs found what they describe as 'virtuous clusters' with comfortable buildings proving to be energy efficient and easy to manage and a pleasure to work in, resulting in a self-reinforcing process occurring. Unfortunately the reverse can also be true, with decline feeding on failure. [41]
- Probe noted that low level problems continually reoccurred in the building studies. They concluded it was caused by the lack of feedback. [42]
- The problem between the predicted computer simulated energy consumption and the actual building consumption [43] continues. Bill Bordass noted that among the low energy building reviewed recently only about a third of the energy consumption has been predicted. [44]

2.05 Benchmarks

Benchmarking is used in building evaluations to assess the performance of the building, or a part of it, against set standards. Key Performance Indicators (KPI's) define the progress towards the benchmark or goal. Benchmarking can raise awareness of the potential to improve the energy performance of a building and encourage proactive management. Buildings should be regularly performance monitored as a form of quality control. [45] Benchmarking buildings and building components with typical, good practice and advanced practice can contribute to better briefing, design, specification, installation, evaluation and management. [46]

Benchmark indicators, and more specifically KPI's, should be used with circumspection because they can too easily become ends in themselves, distorting the data rather than acting as aids to the understanding and assessing what contributes to performance. [47]

The key reference for benchmarking is Guide 19, Econ 19 energy Use in Offices. This document provides representative energy benchmarks for common office types against which a building's performance can be appraised. [48]

The advantage of using the Probe technique for building evaluation is the substantial data base of comparable buildings for benchmarking. With Probe's emphasis on energy, services and sustainability it also provides the ideal method for this study. All three assessment methods used by Probe include benchmarks based on performance evaluations of the building in use:

- Energy Assessment and Reporting Methodology uses "Typical" and "Best Practice" energy benchmarks for each building type. [49]
- Building in Use Survey has benchmarks for each question in the Survey.
- The pressure test is also included in the data base and is benchmarked.

To counterbalance the alarming increase in the use of air-conditioning, a new EU directive came into force in January 2006 known as the Energy Performance of Buildings Directive (EPBD). From October 2008 Display Energy Certificates will be required for all public buildings over 1,000m^2 which shows the energy consumption of the building as recorded by gas, electricity and other meters. This benchmarking is intended to highlight energy efficiency. [50]

For benchmarking the issues concerned with Thermal Comfort, the criteria laid out in the appropriate CIBSE and ASHRAE guides provide the only available data base.

3.00 Methodology

To grasp how an occupied building really works is very complex, although as users we tend to take them for granted. Buildings are dynamic open systems with innumerable apparently relevant interrelated variables. These variables range from the spatial of site, fabric and shape to the interactive of heating, cooling, lighting and ventilation, without even touching on **the complexities of a building's relationship** with the external environment. And the most elusive variable is the interaction between the **physical 'hard' systems** of the building and the **behavioural 'soft' system of the inhabitants.**

The crucial factor in understanding a building is context. Context includes not only just location but also procurement method, design, building operation and management, and how the building is used by the occupants. Much **of a building's performance can be explained by** understanding its context.

Having established that buildings in use are "context dependant" and "multivariate", the method of analysis needs to be based on a "real world" research approach. This method looks less for causes and effects seen in the 'closed' scientific approach than for 'risk factors' and 'consequences' [51] in the real outside world, or **field, you have 'open', often confused** systems consequently you deal with tendencies and probabilities. Causal processes can lead to outcomes, but not always, on the hypothesis there can be multiple mechanisms at work which cause outcomes but there may be other mechanisms which interfere and cancel the outcomes so tendencies and probabilit**ies are used and proofs are 'fuzzy'**. [52] POEs essentially take the form of a diagnosis rather than an analysis with the practitioner simply testing critical points to decipher the building.

Solving problems	rather than	Just gaining knowledge
Predicting effects	rather than	Finding causes
Looking for robust results and concern for actionable factors	rather than	Statistical relationships between variables
Developing and testing services	rather than	Developing and testing theories
Field	rather than	Laboratory
Outside organisation (e g business)	rather than	Research institution
Strict time and cost constraints	rather than	R&D environment
Researchers with wide-ranging skills	rather than	Highly specific skills
Multiple method	rather than	Single method
Oriented to client	rather than	Oriented to academic peers
Viewed as dubious by some academics	rather than	High academic prestige

Fig 6. Real World Research compared with the traditional scientific approach

The Probe technique for building evaluation is used in this study for its emphasis on energy, services and sustainability. The technique uses robust, established methods which are economical with time and effort and collect only the necessary data. This prevents the analysis being mired in methodology. In practice Probe found that only 20% of the available data is needed to discern 80% of the performance of the building. [53]

Probe uses three methods:

- CIBSE TM22, Energy Assessment and Reporting Methodology, which covers building energy performance from both a supply and demand perspective. This helps with a thorough understanding of technical performance of the building for diagnosis.
- Occupant questionnaire which deals with occupant issues such as comfort, health and productivity.
- An Air tightness test to CIBSE TM2314.

In addition, the building is environmentally monitored for temperature, Relative Humidity and CO_2 levels at key points in the buildings at the height of summer and the depth of winter.

The POE analysis needs to be organised in a clearly structured manner to make sense of the building story under three broad headings: Context, Qualities and Implications for user groups

Context includes:

Why the building was needed and for what main purpose
The physical constraints of location, site, and planning considerations
User requirements
Environmental considerations
"Future-proofing" of the building

Qualities

The central goal of any POE is to assess the performance of the building given the context. The qualities or attributes to be assessed in the case of this study are: operations, environment and users.

- Operations: covers the issues relevant to the facilities manager:
- Environment includes: Indoor environment and Energy efficiency
- Users: Information can be derived from numerous sources walk-through, interviews, group interviews as well as the occupant questionnaire. However the occupant questionnaire provides the most objective analysis.

Implications for user groups

The interaction of the various parties concerned with the building are also of interest to the POE. Each party has its own interpretation of good performance and agenda. The balanced interaction between these parties determines the success of the building. The user groups can be separated into four classes:

- Corporate
- Everyday User
- Facilities Manager
- The design team [54]

The building assessment concentrates upon the issues drawn from the building evaluation. The successes are highlighted and the failures discussed for the causes and possible solutions suggested. For this study with its emphasis on energy use, thermal comfort and the validity of the ventilation system the following areas are examined:

- Energy use
- Procurement Method
- Facilities Management
- Ventilation system
- Night-time cooling and purge ventilation
- Building zoning
- Sensors
- Building Management System

The conclusions simply present the lessons drawn from the study of South Cambs as a model for the future; feedback to inform future **design for Bill Bordass's virtuous circle of** continuous improvement.

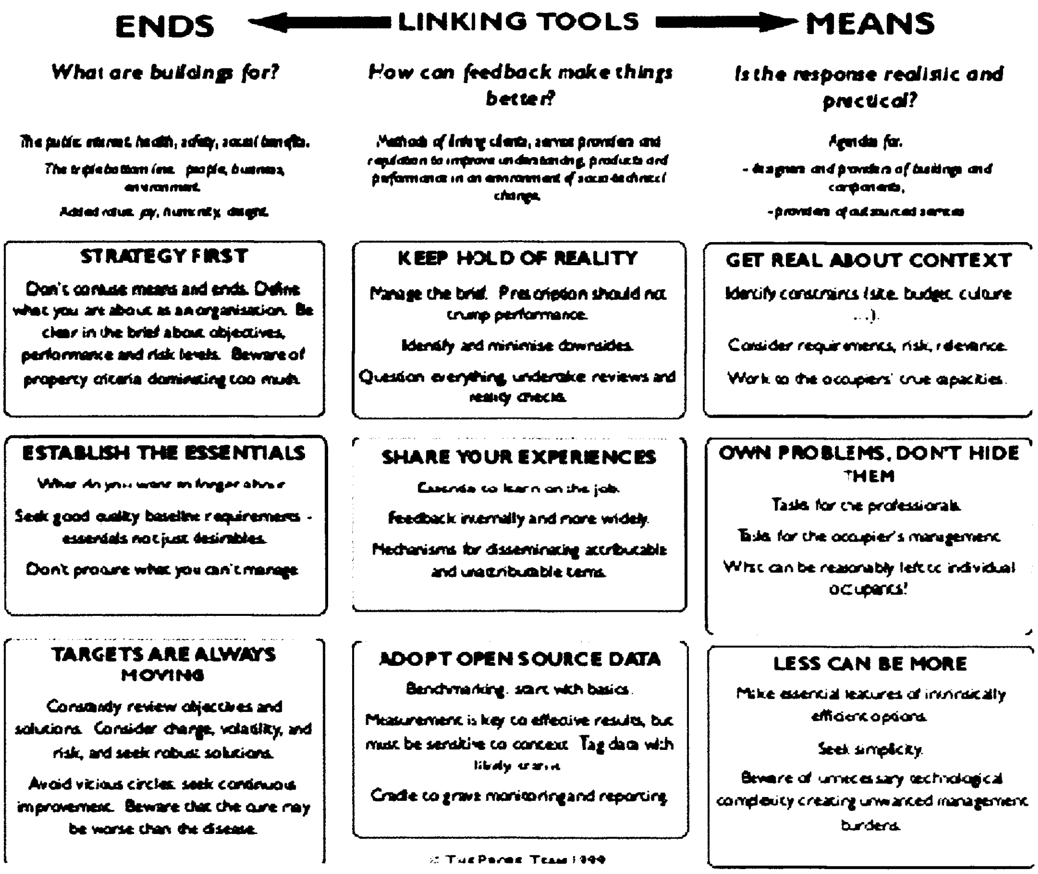


Fig 7. The Probe Matrix showing the Probe approach to Post Occupational Evaluation.

4.00 Building Description

4.01 Background

The decision to a build new Town Hall for South Cambridgeshire District Council (SCDC) in 1999 was prompted as much by symbolism as practicality.

The existing SCDC offices had been located in Cambridge city on three separate sites in inefficient cellular buildings. Aptly described as 'dingy' the offices had poor accessibility for the public and a high turnover of staff. New offices were seen as the solution to these problems.

Keen to establish a separate identity for South Cambridgeshire District Council with new Council Offices away from 'Cambridge City'. Cambourne new town was chosen as the site for the new building in the geographical heart of its own constituency. Although built on a green field site, Cambourne was conceived as growth a area to protect the historically sensitive Cambridge from excessive urban sprawl. The addition of the council offices in the business park provides local and sustainable employment for this new community. [55]

The brief for South Cambridgeshire District Council called for:

"A modern building providing good quality office accommodation... to provide a high comfort working environment that will be adaptable to the defined future requirements of South Cambridgeshire District Council. The building is to be of a suitable civic style for a Council office. It is important the building achieves a pleasant working environment for staff and a welcoming and a pleasant space for the general public to visit."

The accommodation comprises of a Council Chamber, committee and meeting rooms and general office accommodation for the various departments.

From the outset South Cambridgeshire District Council actively supported Agenda 21, the action plan to make development socially, economically and environmentally sustainable in the 21st Century. The design had to embrace energy-efficient low carbon strategies, and targets for reductions in running costs and replacement costs. As a part of the brief the building had to achieve a BREEAM 'excellent' rating. [56]

The limited design competition for the new council offices was won with a design by Aukett Architects in association with Cambourne Business Park, a joint venture between Wrenbridge and Development Securities. The £10.5m contract was 'turnkey' where Cambourne Business Park was responsible for the financing and building of the new offices.

The Developer with South Cambridgeshire District Council on board as a tenant, was inured to the risk of a sustainable design required by the Council and could see the advantages of **expanding its 'green' credentials. The Council did not** want the risk of a bespoke building, so the design had to be flexible enough to be able to sublet space to another tenant or viable enough to sell if they needed to relocate.

4.02 Site

Aukett had been responsible for the master planning of Cambourne Business Park. The new building is located on a new civic square approached alongside a series of feature lakes that form the spine of the design. [57] **The Council's delay in deciding to build new offices in** Cambourne forfeited a more suitable site towards the centre of the new town, which would have placed the building in its municipal heart rather than on the edge.

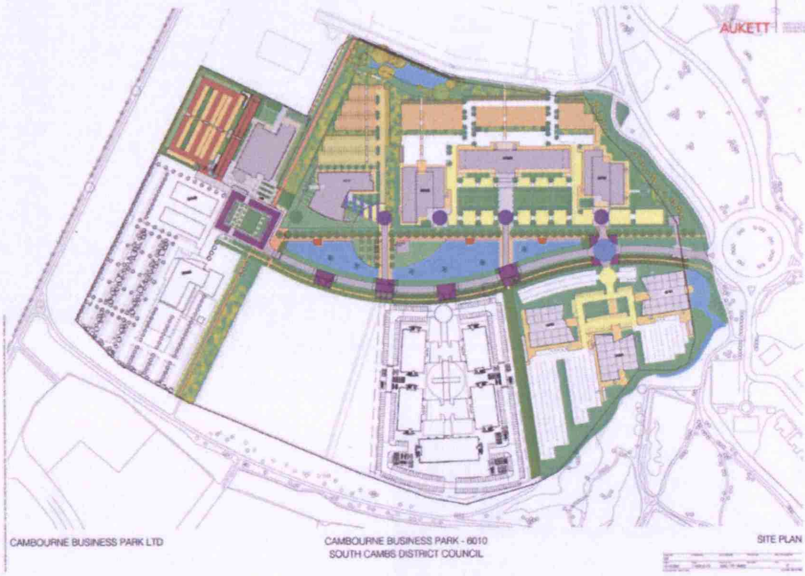


Fig 8. Cambourne Business Park

Fig 9. Perspective of Entrance.

The site layout was dictated by the needs of the building footprint and the car parking. The Council for its own offices needed additional car parking to that of the adjoining offices, consequently the site was constricted for a building of its size. To accommodate all the needs of the Council Aukett were forced to use an orthogonal configuration for the building and car parking within the site.

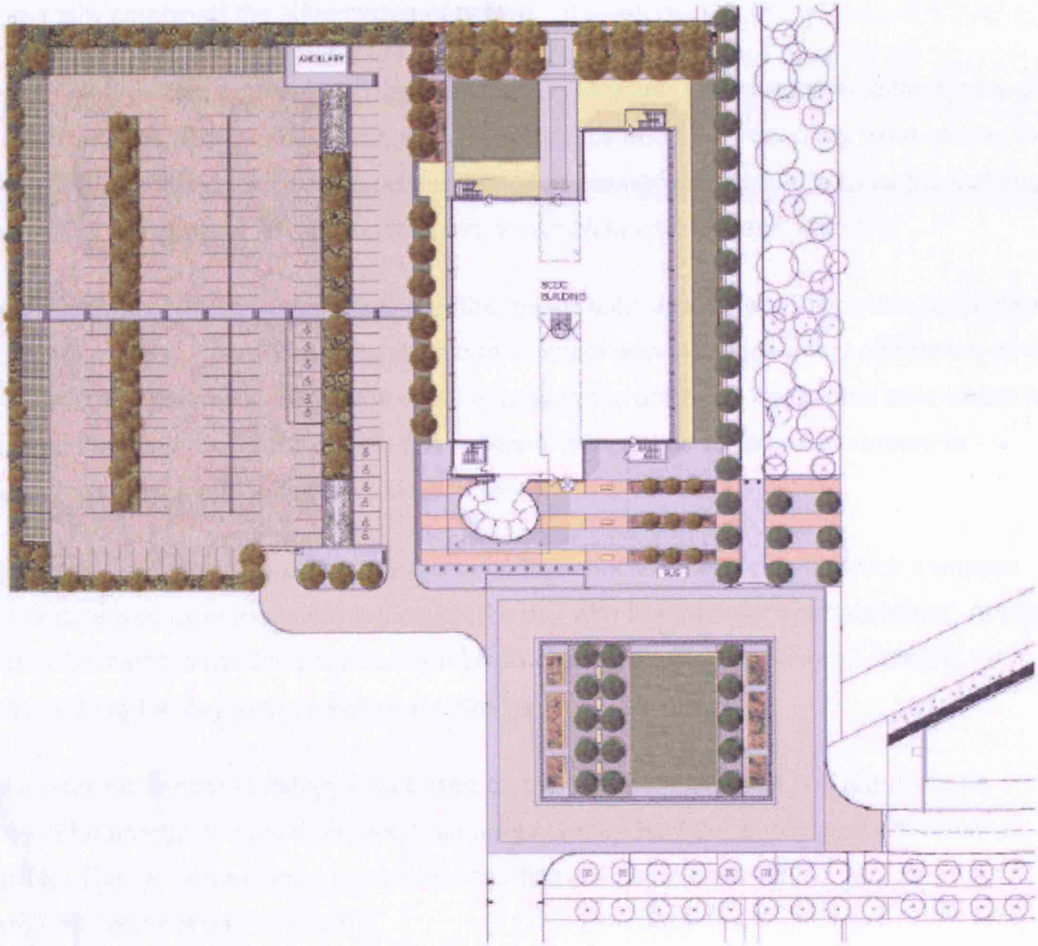


Fig 10. Site Layout

To attain the BREEAM 'excellent' rating, beside the sustainable measures taken with the building, a travel plan was needed and specific nature conservation measures on site. [58] The full breeam submission is in Appendix B.

4.03 Outline Design

The key issue for the design development of the building was environmental control. It became a subject of much debate within the council. Initially two options were forwarded: air-conditioning and natural ventilation. The air-conditioning offered the adherence to the stringent environmental control criteria set out in the brief, while natural ventilation provided the low energy use the council desired for an environmentally friendly building. A compromise solution was accepted with complementary mixed mode ventilation that theoretically combined the advantages of both.

Areas of high cooling demand such as the Council Chamber and internal meeting rooms are provided with the normal air-conditioning. Reassurance and future-proofing were offered to the council by ensuring the design retained enough flexibility in section to allow the building to be converted to either full air-conditioning or complete natural ventilation.[59]

A central street of atria forms the spine of the design with simple central corridor open plan offices either-side. The offices naturally cross ventilate with the stack effect so that the air is drawn from the perimeter across the working area in the offices to the central atria where it rises into the lantern over the street. The reservoir of hot air is expelled in summer or mechanically extracted and re-circulated in winter.

The thermal mass of the building is exposed with a concrete ceiling soffit which dampens temperature swings in the building through the day **with the thermal 'flywheel effect'. At night** the thermal mass is used to provide night-time cooling, reducing the energy demand for cooling during the day in the summer months. [60]

The overall sustainable strategy was based on the sound precepts of first reducing the demand for energy and then meeting the energy demands of the building as efficiently as possible. The various systems used in the building are complementary to reinforce the energy efficiency of each device.

To reduce demand:

Low infiltration rates
Good thermal insulation
Thermal mass of the exposed concrete
Night time cooling
High daylight factors on perimeter with natural lighting
High daylight factors on street with natural lighting through ETFE roof
External shading to prevent solar gain
Solar performance glazing

To satisfy demand efficiently:

Heat recovery from lantern on Air Handling units using thermal wheels

Displacement ventilation for heating and cooling

Energy efficient lighting

Low NOx, high efficiency condensing boilers

Compensated perimeter trench heating for preheating the building

Air-cooled chiller for Air Handling unit

Building Energy Management system [61]

The Outline mixed mode Ventilation strategy evolved to work on four modes over the day and night:

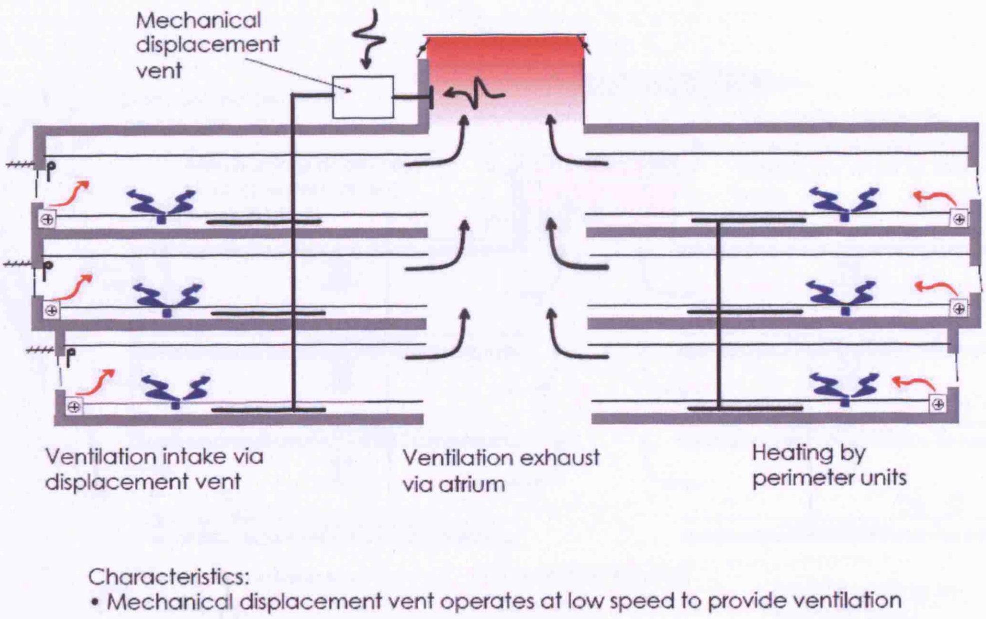


Fig 11. Ventilation Strategy: Early Morning Heating Mode

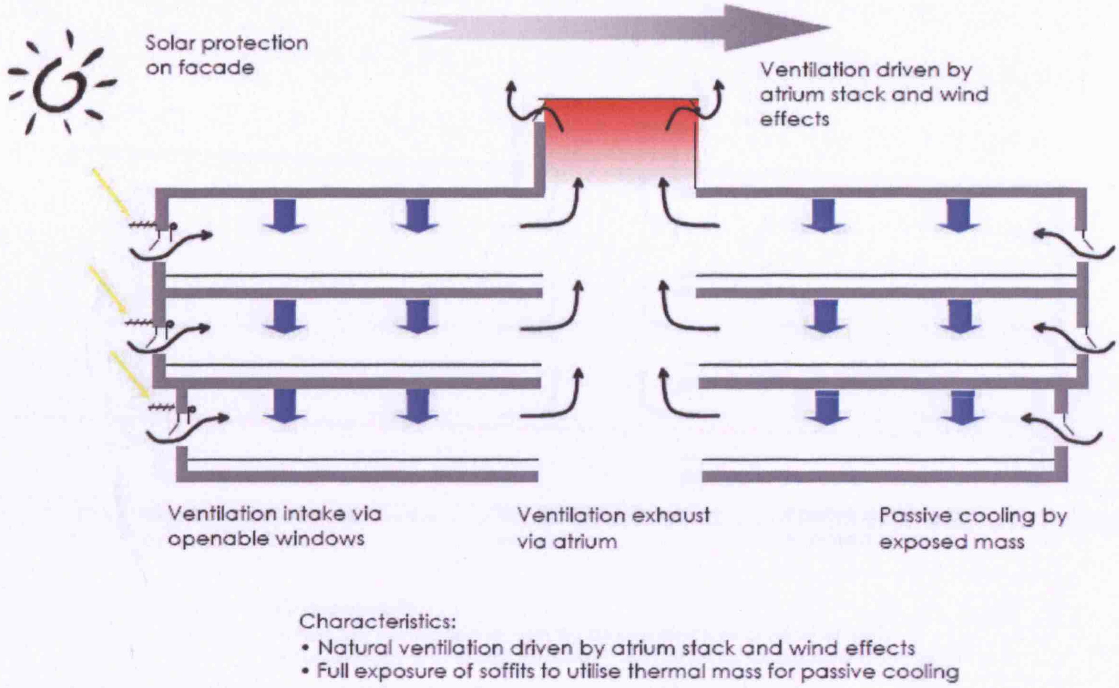


Fig 12. Ventilation Strategy: Late Morning Natural Ventilation Mode

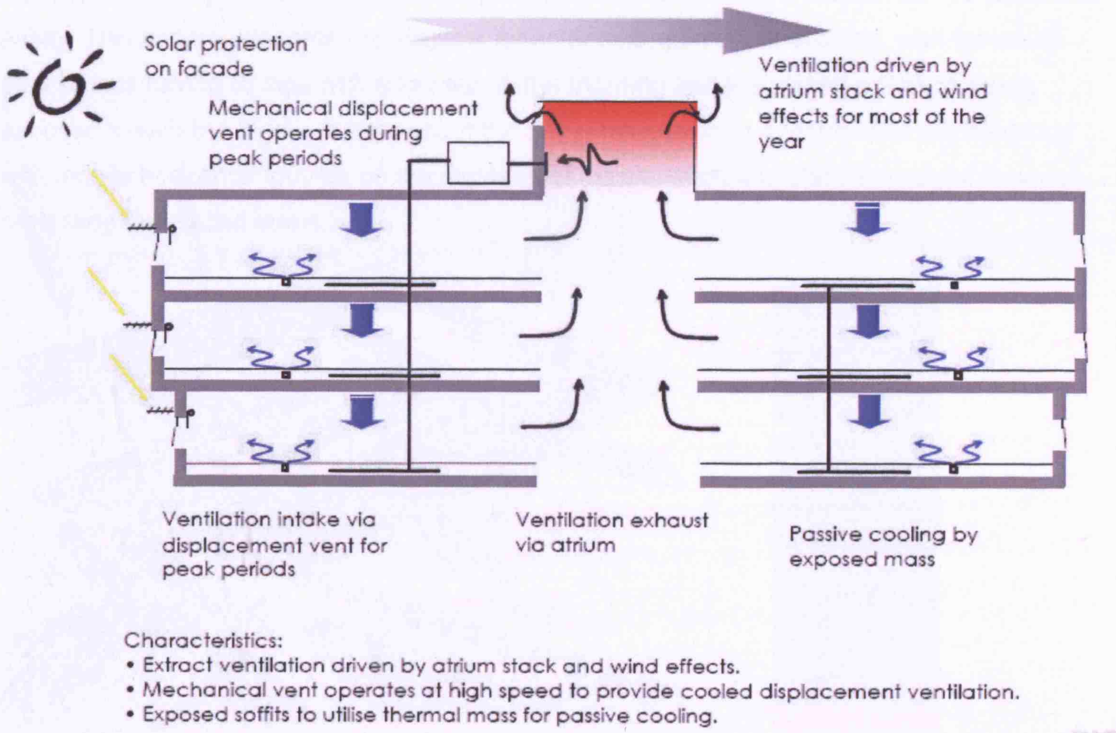


Fig 13. Ventilation Strategy: Afternoon Displacement Ventilation Mode

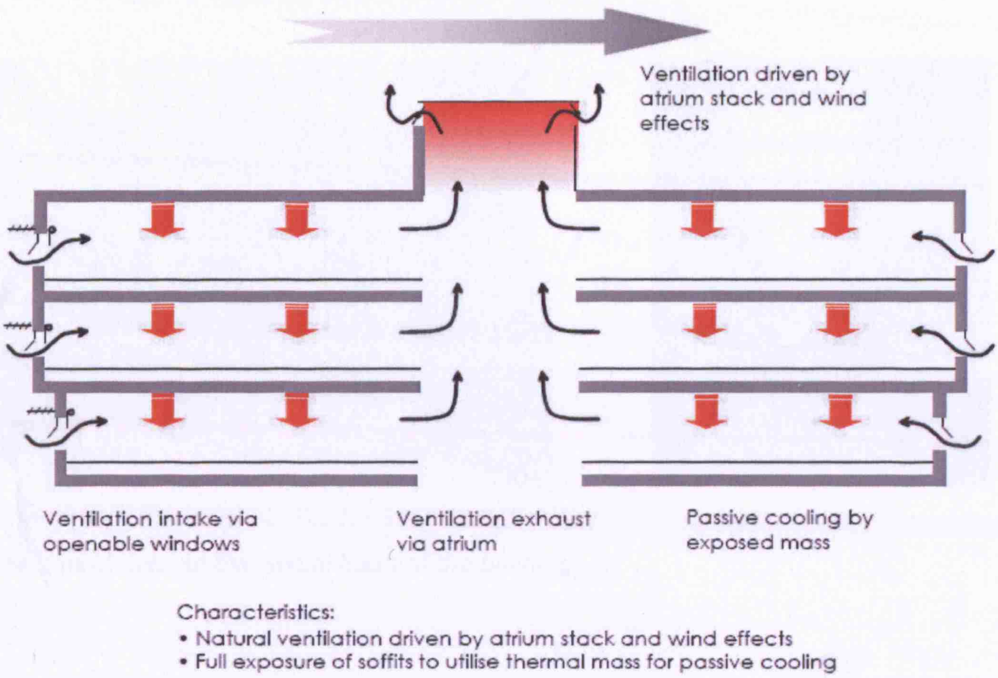
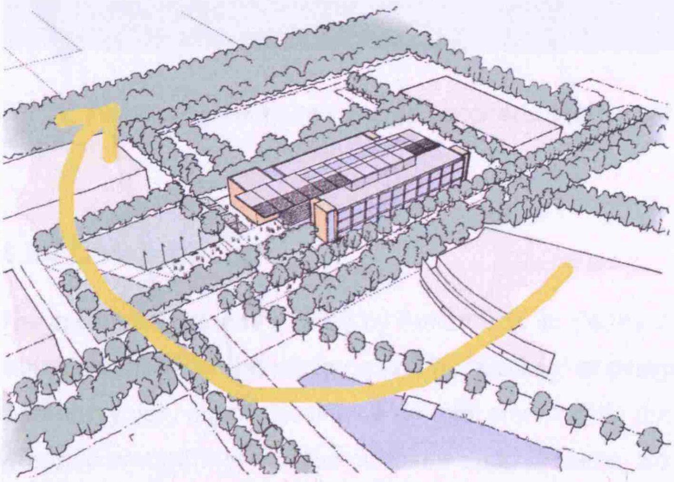


Fig 14. Ventilation Strategy: Night-time Cooling Natural Ventilation Mode

The building orientation on the site causes problems with solar penetration into the building. Unfortunately the site is not on a north-south east-west axis so with the orthogonal site layout the building is skewed away from the ideal orientation where the sun can be dealt with easily. This has troublesome implications for solar heat gain in the building, with the south east façade having to deal with a low sun in the morning and the glazed entrance being exposed to with the high sun throughout the day. This has been expressed in the elevation with mobile horizontal louvres on the exposed office elevation and static horizontal louvres protecting the glazed street.



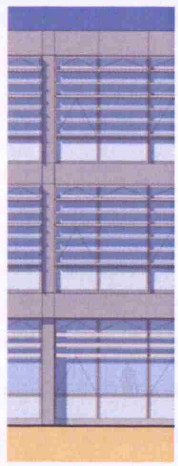


Fig 15. Sun path around Building and elevation louvres

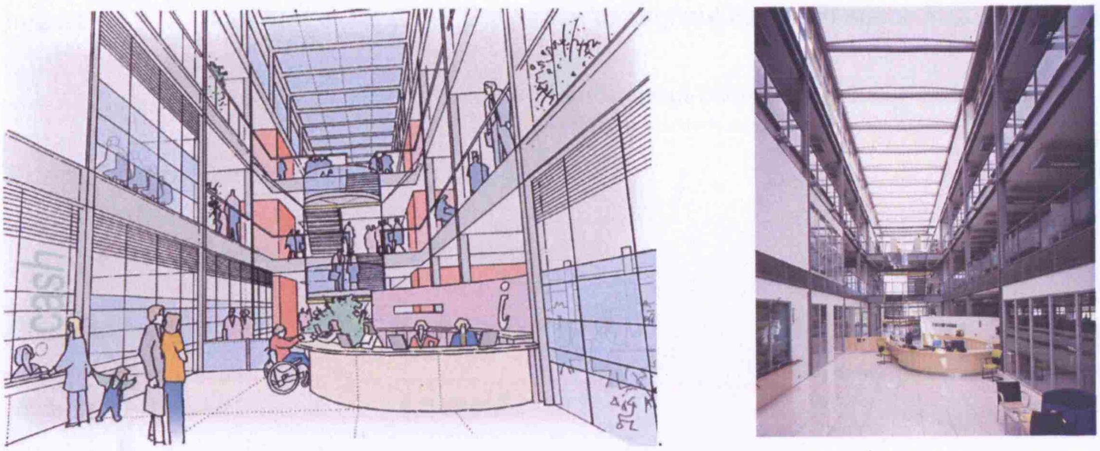


Fig 16. The Street acts as the Social heart of the building

Fig 17. Externally the Aukett design succeeds in being at once Modern and Municipal

4.04 Detail Design

The competition winning entry by Aukett with its clearly delineated elements makes a very suitable vehicle for the packages of the 'turnkey' or design and build contract. The design is essentially very simple having; a skeletal steel frame; precast concrete flooring and roofing; wrapped around with various curtain walling systems. So the building is easily broken down into simple economic packages aiding speed of construction and economy.

4.05 Environmental Design Criteria:

Internal	Summer	23+2°C average throughout occupied space including street
	Winter	19°C average throughout occupied space including street
External	Summer	28°C db, 21°C wb
	Winter	-5°C Saturated
Occupancy		**1 person per 10m²**
Minimum Fresh Air		**1.6 l/s/m²**

Operation of the mixed mode ventilation system works as follows:

Heating Mode below 10°C ambient

Automatic windows close to office areas
The air handling plant supplies room temperature air with a displacement ventilation system at 18°C at a nominal rate of 1.6 l/s/m², which can drop to 1.0 l/s/m² if CO_2 sensors permit. Heat reclaim is used from the air discharge in the lantern.
The office space is heated with perimeter trench heating

Natural Ventilation Mode between 10°C and 20°C ambient

Automatic windows controlled by the window operating system maintain temperature and CO_2 levels
The office space is heated with perimeter trench heating when needed
In adverse weather the windows close and the displacement ventilation system operates

Cooling Mode above 20°C ambient

Office perimeter windows close
Lantern windows open to allow warm air discharge to atmosphere
The air handling plant supplies room temperature air with a displacement ventilation system at 18°C at a rate which can rise to 4.0 l/s/m² controlled by the on-floor dampers

Night-time Heating

All windows shut

Perimeter and under floor heating to maintain night-time set back temperatures

Night-time Cooling and Weekend Cooling

Natural ventilation

Purge ventilation in the morning during the week to freshen the air

Control System:

The switching of the system from mode to mode is automatic controlled by the building management system (BMS) with information from the sensors located on each floor monitoring CO_2 levels and temperature. The BMS system communicates with the window control system.

The office areas are separated into the six zones of the floor plates. The system has the flexibility to operate with separate zones in two different modes at any one time but not three modes.

In Natural ventilation mode the windows are controlled in zones by the specialist window operating system. The windows are fully modulating and incorporate manual overrides at the perimeter of the building. The window control system responds to the internal temperature and CO_2 concentration whilst allowing for the external conditions of temperature, wind speed, wind direction and rain. [61]

The final operating configurations:

Mechanical Heating Mode

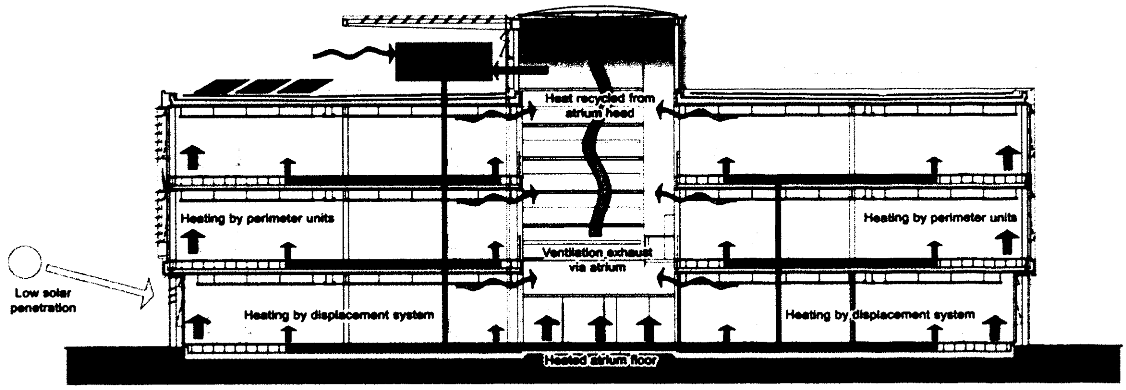


Fig 18. Final Ventilation Strategy Mechanical Heating Mode

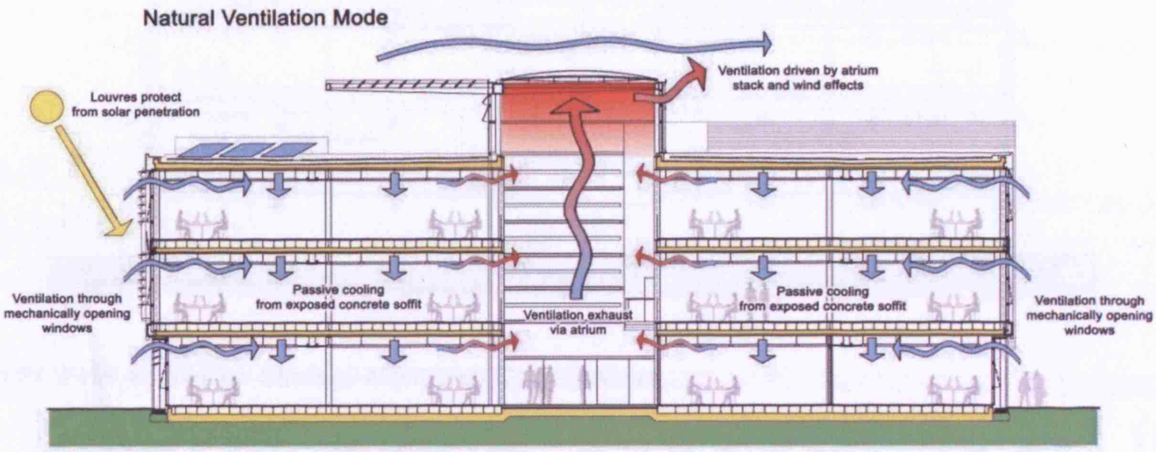


Fig 19. Final Ventilation Strategy Natural Ventilation Mode

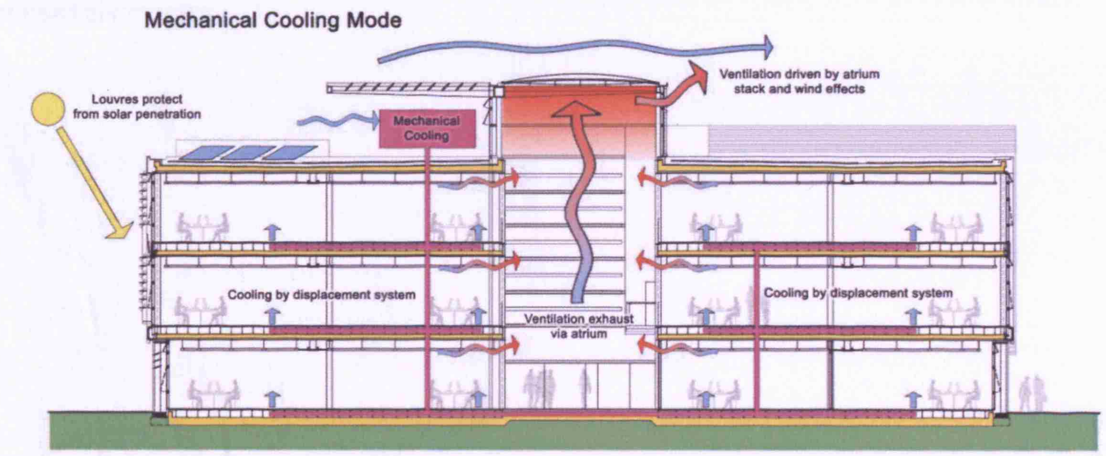
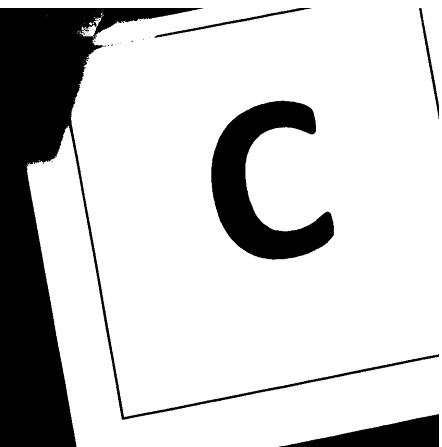


Fig 20. Final Ventilation Strategy Mechanical Cooling Mode


C

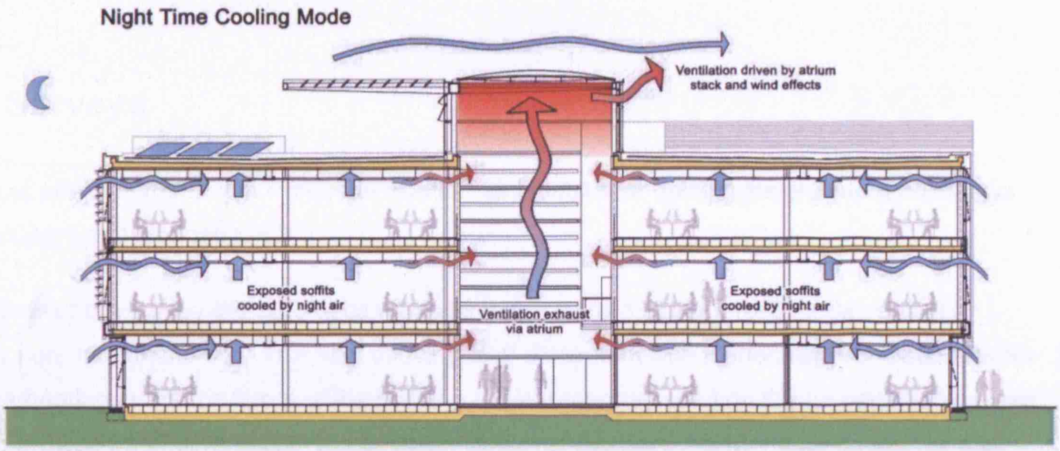


Fig 21. Final Ventilation Strategy Night-time Cooling Mode

4.06 Post Completion

The building was monitored by Faber Maunsell for a year after completion. Problems occurred with the automated windows specialist operating system working with the Building Management System. It was found in practice that the two systems had trouble in communicating. As the operation of the two systems in conjunction with one another is crucial to the way the whole building works, the problem had to be resolved and it took Faber Maunsell six months.

5.01 Surveys

The most effective method in Probes evaluation techniques for gaining insight into a building is the Occupant questionnaire. [62]

At the time of the survey the automatic windows in the lantern of the mixed mode ventilation system were malfunctioning. This was causing staff discontent with inadequate ventilation levels and overheating in the top floors of the building. As a temporary solution the air-conditioning was used to provide fresh air and cool the building. However the Facilities Manager mindful of staff discontent considered an occupant survey too contentious.

In lieu of the Occupant Survey information concerning the building has been garnered from the staff whilst visiting the building to place the hobo sensors during March and June. Although this information does not have the statistical validity of an occupant survey it does clearly establish the inherent problems within the building, particularly with thermal comfort.

The full record of the visits is in Appendix C only the salient points are noted:

Thermal Comfort:

- The top floors are hotter than the ground floor especially later in the day
- The air inputs from the displacement ventilation are too close to staff at desks causing discomfort from cooled air.
- The people in reception develop headaches from the stuffy air in the afternoon and have asked for entrance doors to be opened.
- A member of staff located inboard on the office floor plate on the first floor complained of developing headaches towards the end of the day. She found the air and atmosphere stuffy.
- The building temperature not uniform along its length it tends to be cooler to the entrance end. One secretary had resorted to using miser's mittens to type.

Control Issues:

- The temperature sensor for the floor plate on the southeast side is located next to the printers and photocopiers.
- The BMS system runs the whole building by a remotely controlled computer system. The whole system needs resetting after a power cut by the remote controller. Running of building control system out-sourced.

- Cooling in hot weather cuts in when a threshold temperature is reached in the building. The occupants to gain a cooling breeze, open the windows which delays the temperature rise for the chillers to cool the building. Caretaker goes around the building asking the staff to shut windows to cause the temperature to rise so the chillers work.
- Overheating occurs on shade or car-park side of the building in the evening. No shading allowed for in the design.

5.02 Meetings

To gain a thorough understanding of the building and the build process a series of semi-structured interviews were conducted with the professional parties concerned. A full draft of each meeting is in Appendix D for brevity only the salient issues are noted.

Anna Lumsden: Associate Aukett Architects

Meeting in Bristol 14th September 2007

Anna outlined the structure of the design and construction teams and where the building had been published. Closely involved with the build she noted that it had been constructed quickly they had problems with quality control and the costs had been pared to the bone.

Peter Eaton: Director Aukett Architects

Meeting at Aukett Fitzroy Robinsons Regent Street Office 12th June 2008

As Director Peter was involved from inception to completion at South Cambs the most important point he made was that McAlpines the contractor had struggled to manage the organisation of the Contract. The building had four separate contacts for controls and wiring on site!

Brent O'Halloran: South Cambridgeshire District Council

Meeting at SCDC 10th June 2008

- At present the roof vents are not operating the council is in discussion with the software operator and the window supplier about who is responsible for the cost of rectifying the problem.
- Complaints about cold in the morning suggest that the slab is being overcooled.
- **Heaters under desks to overcome 'coolth' from night-time cooling.**
- Fans also used for cooling when the building is hot.
- Facilities Management to change the system have to ring the remote controllers of the BMS system this provides a very slow response and is very frustrating.
- Brent acknowledged that South Cambs need a full-time facilities manager to run the building. The recent appointment of a part-time manager had caused problems that he was unable to address due to other work commitments. The original Manager had retrospectively been the correct appointment as he had, in an unappreciated way, run the building smoothly solving problems as soon as they had occurred.

Adam Mathews: Architect SCDC designer

Meeting in North Greenwich at Office of Adam Mathews 26th June 2008

1. The development client had been more open to the risk of a mixed mode building because already had South Cambridgeshire as a client. The task was to convince South Cambs that a sustainable building was a good idea this was done by highlighting the forthcoming Legislation for Sustainability and Energy use from European Directives. The prime example being the just introduced Energy Certificate for Public Buildings. Also the lifecycle costing of the building was emphasised to justify slightly higher expenditure. Development Securites could see the advantage of sustainability as an added attraction for marketing the building. Also they could let the building at a higher price because the running cost would be lower.
2. SCDC was also developed so it could later in life be let as a speculative office let should the Council move. The building was also designed as an extrusion so it could be extended. The escape stairs being dismantled and re-erected at the end of the new extension.
3. Mathew though building control for the occupants should be simple and understandable. People have become used to AC and do not know when or when not to open a window for example opening a window on a hot day when it will simply let in hotter air.
4. The control systems for windows that automatically after went back to a default position **after being opened were 'value engineered' out.**
5. The design was conceived with rule of thumb garnered from BRS publications particularly the Environmental Design Guide.
6. Latterly in the design Fabers became concerned about the opening windows free area in the lantern which was not adequate in the sub-contractors detail drawings.
7. The Plantroom grew despite the efforts of the architect in part due to the fact it was a design and build contract. The plantroom started to impinge on opening windows in the top of the lantern. Ironically in the finished building the plantroom is very generous because the actual services contractor rather than the design consultant did not need the space.
8. The wind rose for the site had no effect on the design the street lantern is designed solely to work with the stack effect.
9. The temperature levels set by Fabers came from the CIBSE AC standards rather than the BRE standard which was looser. With the temperature problems in the building the question must be asked are AC temperature criteria suitable for a mixed mode building.
10. Adam had hoped that over time the use of the AC would fade away and the building would have simply become naturally ventilated. Although the building was designed so later in life it could be fully Air Conditioned.

Phil Craig: Regional Director Faber Maunsell

Meeting in St Albans at Faber Maunsells Office 30th June 2008

1. Initially the BMS did not work correctly. The sophisticated window system by Window Master an associate firm of Velfac the window and curtain walling manufacturer for the project had its own control system which did not communicate with the BMS system. It took 6 months to sort the teething problems out.
2. In high winds, prevalent in Cambridgeshire the window openings are designed to adjust with pressure sensors along the facade.
3. The window control system used purge ventilation in the morning.
4. Phil Craig was aware of the problem of the print machines and photocopiers being located next to the temperature sensors for the BMS. This problem had occurred at a late date in the fitting out and no budget existed to move the sensors. The professional decision had been that it would not distort the readings to the BMS unduly as modern copiers have a low heat output.

Graham Middleton: New Facilities Manager South Cambs

Meeting at South Cambridgeshire District Council 13th August 2008

1. Graham provided South Cambs energy figures which are due to be posted on the Energy Certificate for a public building in October.
2. Discussing the problems with the building Graham noted that the sensors running the BMS system are located in the chiller enclosure. Due to the heat output of the chillers this has a separate microclimate to the outside so the BMS is receiving distorted external readings.
3. Graham described the internal environment as one of extremes either too hot or too cold.

5.03 Air Infiltration

South Cambridgeshire District Council was tested for air infiltration as a part of compliance with Part L of the Building Regulations 2000. The requirement for the building was an air **permeability of 10.86m³/h/m² the Council Offices achieved** 7.58m³/h/m². [63] From CIBSE TM23 this represents Best Practice standard.

	Air Leakage $m^3/h/m^2$	
Building Type	Good Practice	Best Practice
Office air-conditioned	5.0	3.0
Office naturally ventilated	10.0	7.5

Fig 22. Air Infiltration Standards

5.04 Energy Consumption

The method and benchmarking of the energy consumption of the building is from Econ19. The method is enclosed in Appendix E. The Good practice and typical practice energy use standards are derived from taking the mean of the good practice and typical practice standards from a standard air-conditioned office and a naturally ventilated office. [64]

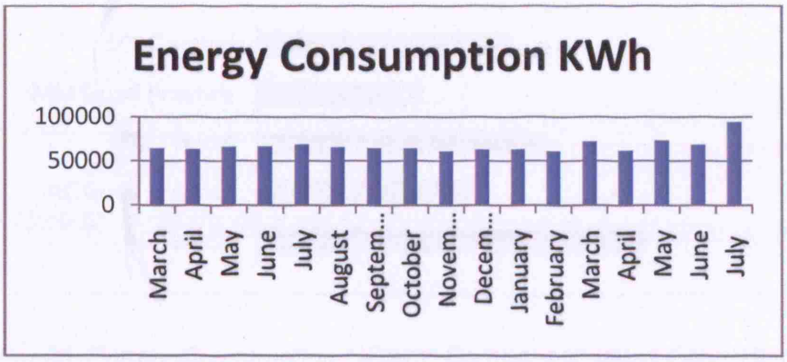


Fig 23. South Cambs Energy Consumption 2007-2008

The energy consumption results show that **SCDC's performs between the mixed mode** standards of Good practice and typical practice. For a newly constructed building this is disappointing as the energy performance is no better than a good practice air-conditioned office. The use of electricity is proportionally higher in SCDC than the standards for mixed mode buildings and air-conditioned buildings this suggests that something is awry with the operation of the building. The current energy consumption figures are used for comparison during this period the automatic windows have not been working correctly. This suggests that the air-conditioning has been used too frequently. For the comparison the very high energy use of the air-conditioning during July was excluded and an average figure substituted.

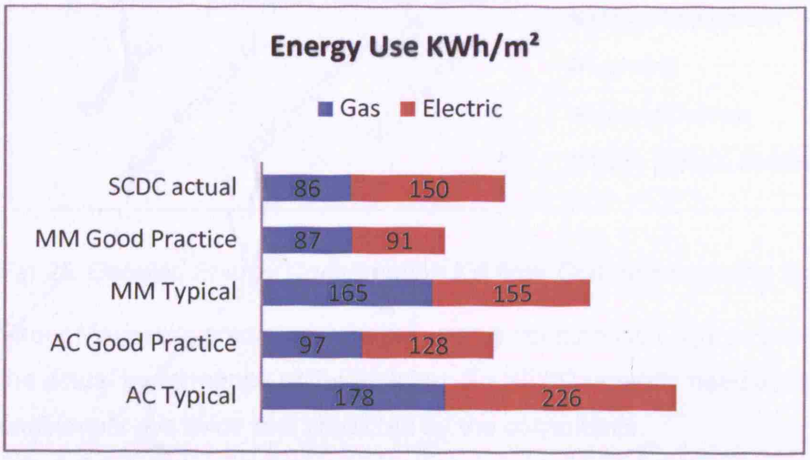


Fig 24. Energy Consumption KWh/m² Comparison using Econ 19 standards

When considering the carbon dioxide emission figures SCDC fares even worse as CO_2 emissions for electricity are comparatively higher than gas due to the inefficiency of conversion to energy.

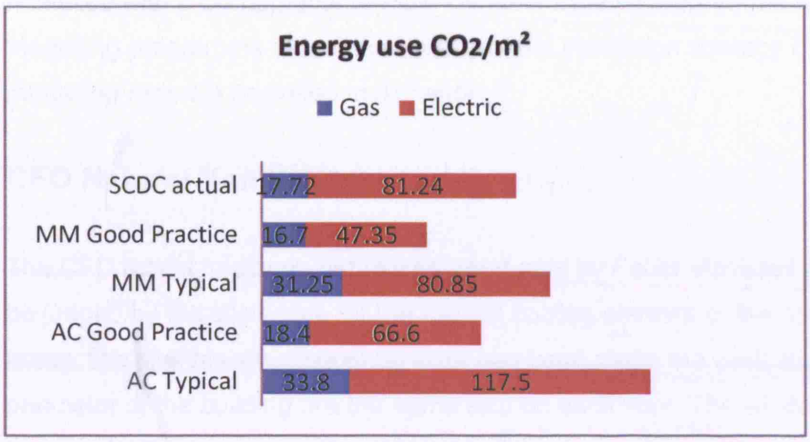


Fig 25. Energy Consumption CO_2/m^2 Comparison using Econ 19 standards

The Breakdown of Energy Consumption is derived from calculations prepared by Faber Maunsell for the submission for the British Council for Offices award. Its inclusion is to illustrate where the energy benefits occur in a low energy mixed mode ventilated building as compared to a typical and good practice air-conditioned building. Note Fabers have used typical and good practice air-conditioned offices as a comparison.

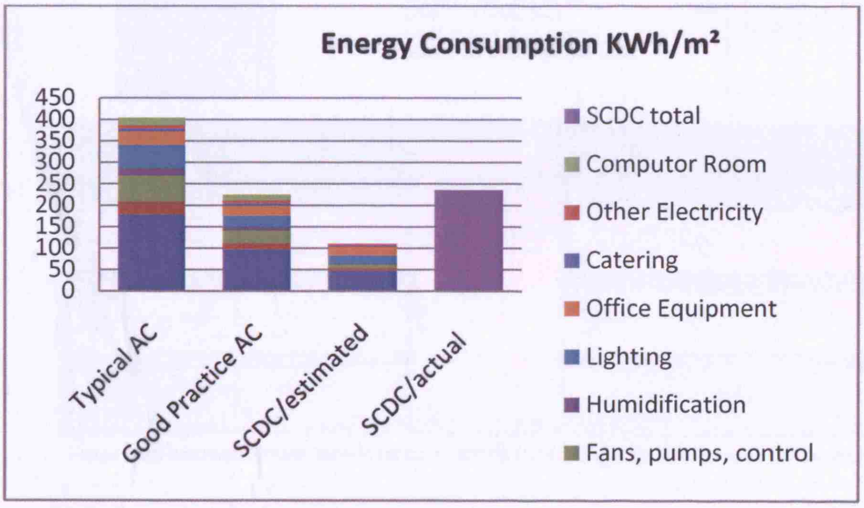


Fig 26. Detailed Energy Consumption KWh/m² Comparison using Econ 19 standards

Faber Maunsells predicted detailed energy consumption figures are substantially lower than the actual performance of the building. So SCDC urgently need an energy audit as consumption is twice that predicted by the consultants.

5.05 Computer Modelling

As a part of the design exercise for South Cambridgeshire District Council the building was modelled with a Computational Fluid Dynamics (CFD) programme and a Dynamic Thermal Modelling programme to test the validity of the ventilation strategy by Faber Maunsell. The modelling report is enclosed in Appendix F.

CFD Natural Ventilation

The CFD model has been setup with great care by Faber Maunsell the attention to detail can be judged by the allowance for the radiant cooling element of the concrete soffit to the floor areas. Despite this a fundamental error has been made the ventilation openings on the perimeter of the building are the same size on each floor. The window should progressively become larger as you rise through the building to create a uniform pressure gradient across the floor plates on each level. [65] This effect can be seen in the model with more penetration of the cooler air into the floor space at the lower floors. So the only valid area in the model for the temperature across the floor plate is the first floor. The stratification of the cooler air can be seen in both the long and cross section at the lower floors.

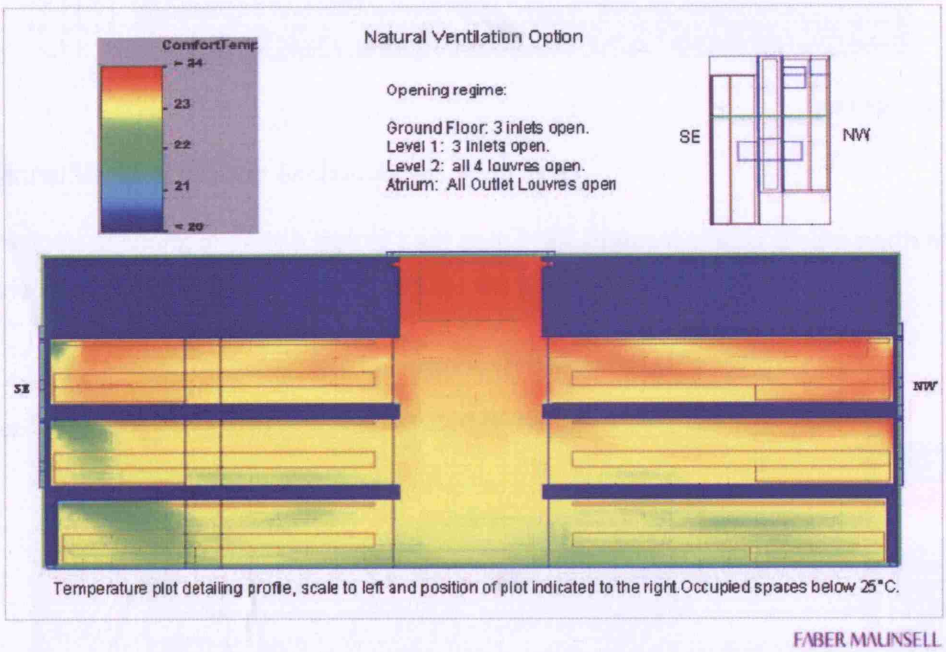


Fig 27. CFD Natural Ventilation Cross Section

The model shows that either the capacity of the lantern to retain the warmed air or the size of the extract openings to expel the warmed air could be a problem. Some spillage of warm air into the adjacent second floor is shown this would cause overheating and discomfort for the occupants. Concern was expressed in the building about over heating late in the day on the top floor suggesting that this effect may be occurring. Certainly Faber were concerned about the opening sizes of the ventilation extract in the lantern increasing their size quite late in the design process and insisting the sub-contractors drawings be amended to reflect this as the window areas had been reduced as a cost saving. This needs testing with temperature sensors at a high level in the working building.

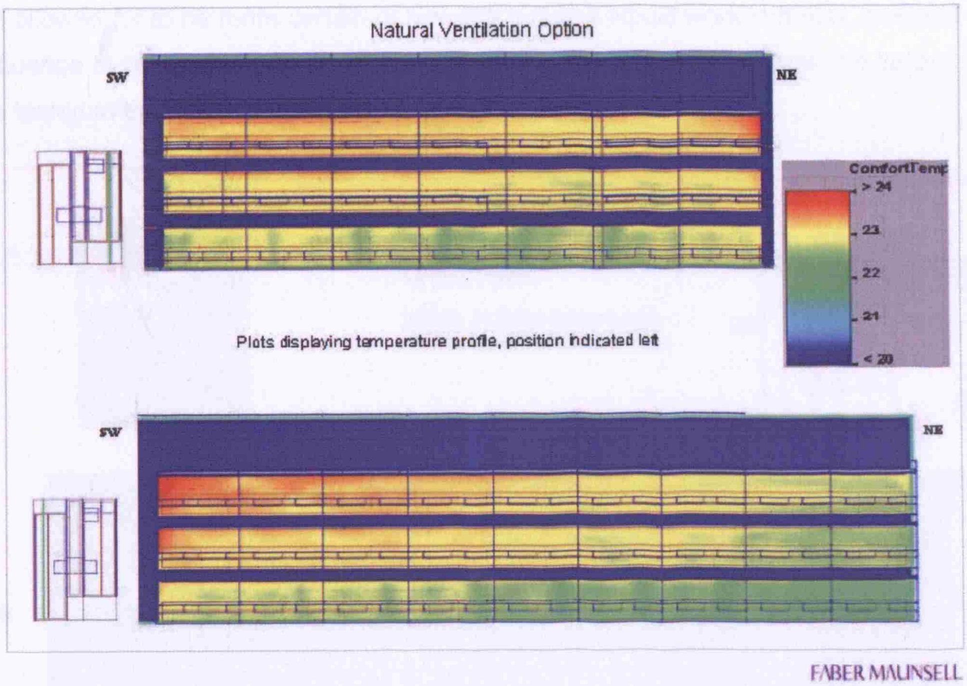
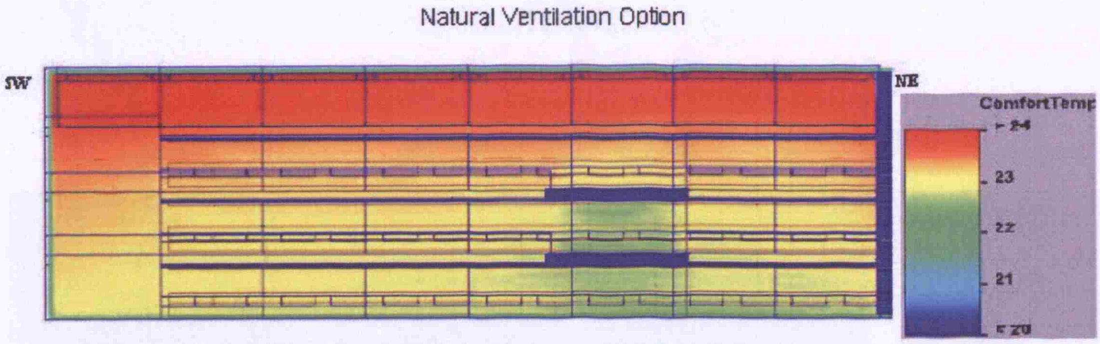


Fig 28. CFD Natural Ventilation Long Section A

The long sections show the lack of heat gain from adjacent offices on the north end of the atria and the solar gain at high level from the glazed façade.



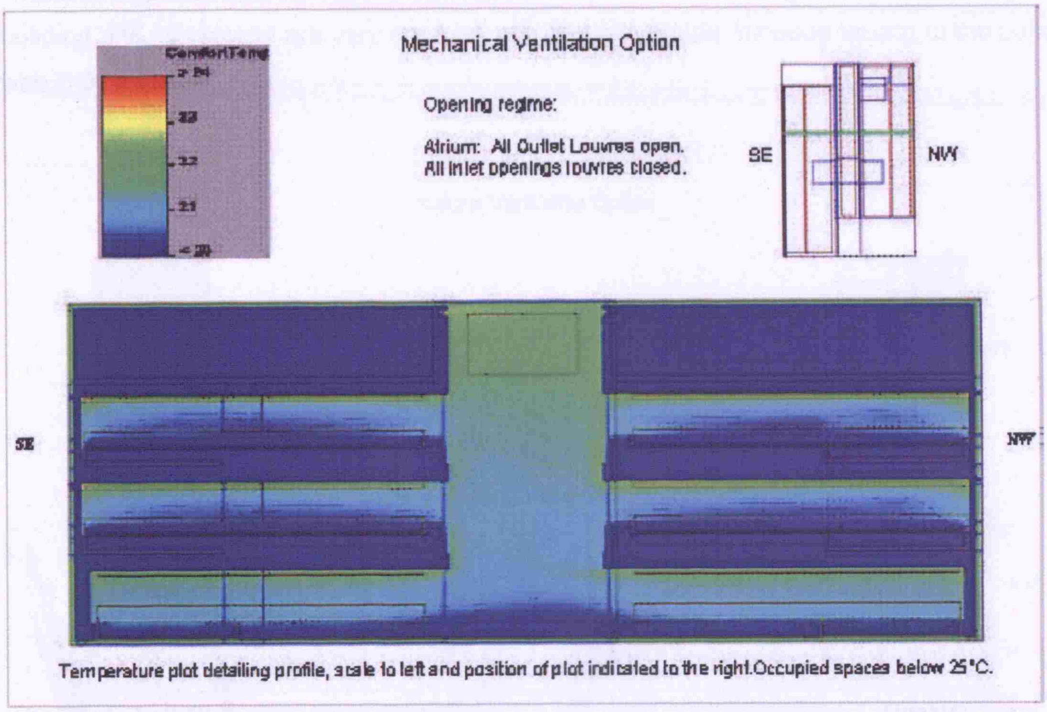
Above: Plot displaying temperature profile though centre of atrium (indicated bottom right), scale indicated left.

Fig 29. CFD Natural Ventilation Long Section B

The air is cooler under the landings again due to the lack of heat gain from the adjacent offices due to the toilet and lift blocks.

CFD Mechanical Ventilation

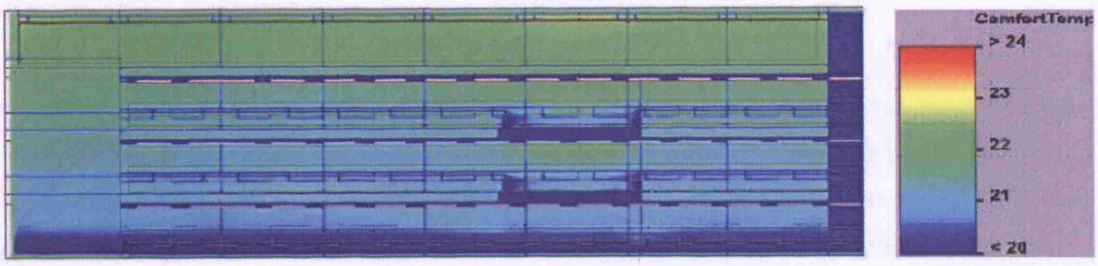
The temperature gradient across the floor plate in both sections is very uniform, as would be expected from the displacement ventilation system. Again, as with the natural ventilation, the capacity of the lantern or the speed of extract could be doubted with some slight impingement of the air quality in the top floor. A larger margin for error in the design should be allowed for to be more certain of how the building would work in reality, perhaps the influence of value engineering on the project. As with natural ventilation the lantern needs to be tested in the working building.



FABER MAUNSELL

Fig 30. CFD Mechanical Ventilation Cross Section

Mechanical Ventilation Option



Above: Plot displaying temperature profile though centre of atrium (indicated bottom right), scale indicated left.

Fig 31. CFD Mechanical Ventilation Long Section

Thermal Model: Natural Ventilation

As with the CFD model the perimeter ventilation openings are modelled as a uniform size on each floor of the building so only the first floor can be taken as a valid result. The concerns expressed by the occupants of the building about stale air in board on the floor plate and in reception at the base of the atria are shown in the model. Whilst the air shows a vigorous mixing at the perimeter the air movement across the floor plate becomes progressively more static. With the air also being warmed as it crosses the floor plate rising to the soffit it must be questioned how much fresh air actually reaches the occupants inboard. Certainly the relationship between the temperature differential between incoming air and the air in the building and its velocity are very complex and highly variable. It needs testing in the building with CO_2 sensors.

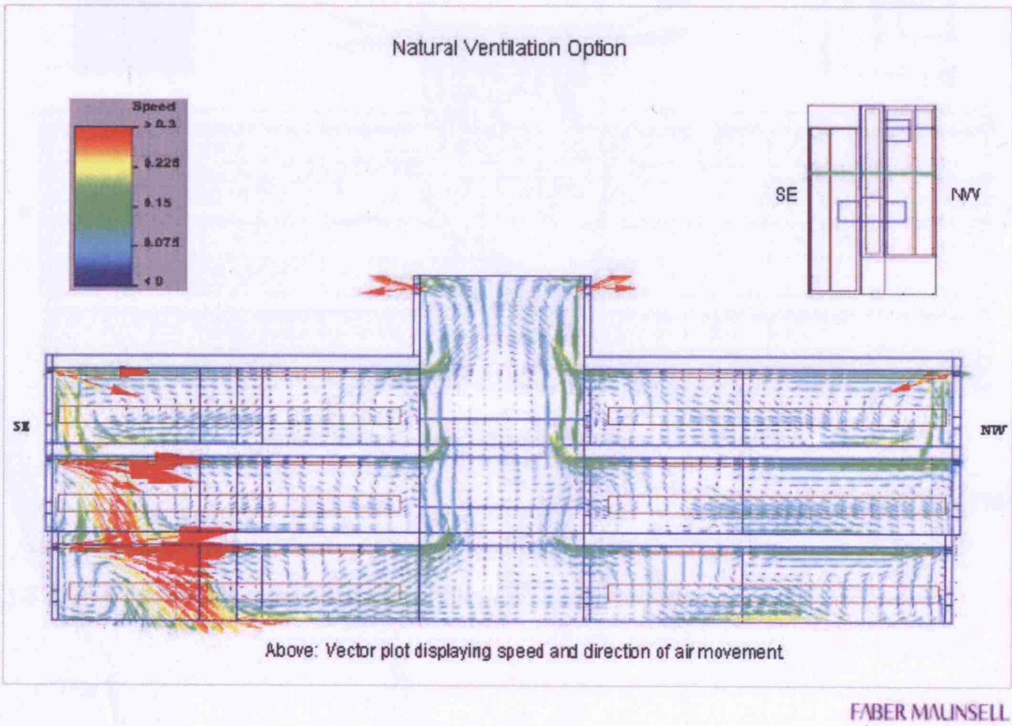


Fig 32. Thermal Model Natural Ventilation Cross Section

The stronger air movement into the building on the southeast side rather than the northwest side can be explained by a cross wind in the weather file forming a positive pressure zone on the windward side. If the crosswind is vigorous enough a negative pressure could be formed on the leeward side preventing the stack effect working. The automatic window system is designed to allow for the differential pressures along the façade of the building. Oddly although the model shows the effect of a higher wind pressure on one side of the building it is not apparent in the lantern with it venting uniformly both sides.

Thermal Model: Mechanical Ventilation

As expected with a displacement ventilation system the air movement across the floor plate is very even although the base of the atrium in reception shows the air to be static. The population density in this area is very low for the area so it would not have caused concern. Air movement in the atria is far more vigorous than the natural ventilation model suggesting the air movement in the natural ventilation model may be inadequate as the air flows are controlled in the mechanical model.

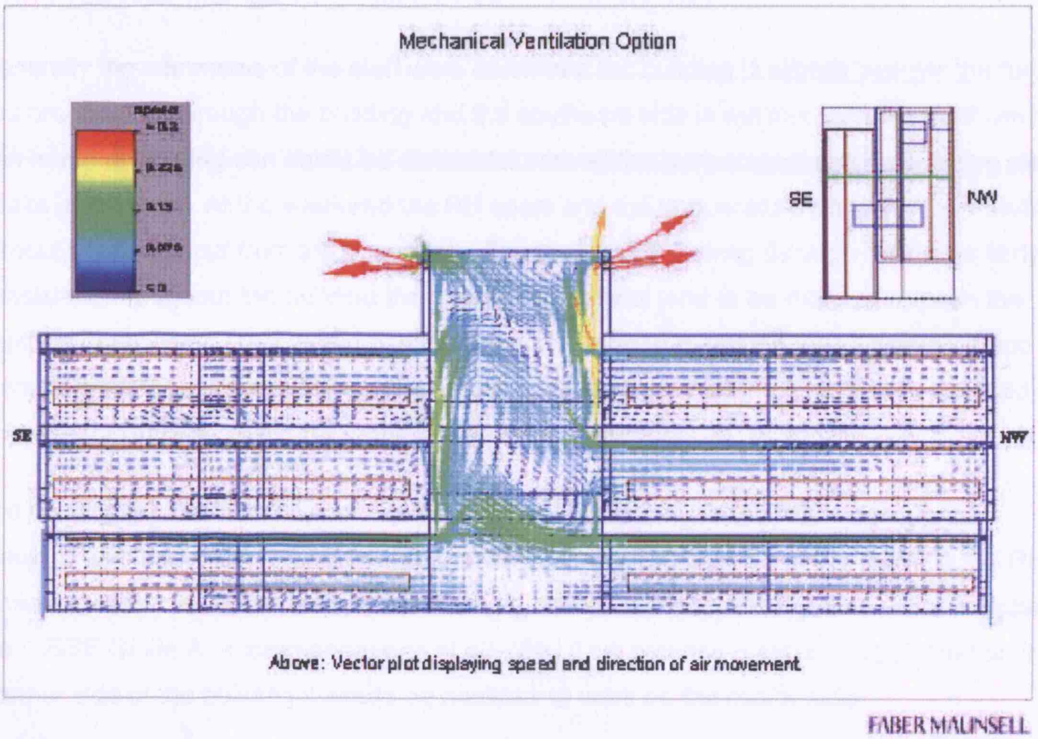


Fig 33. Thermal Model Mechanical Ventilation Cross Section

Below: Plot displaying direction of air movement only, taken through centre of atrium (indicated bottom right).

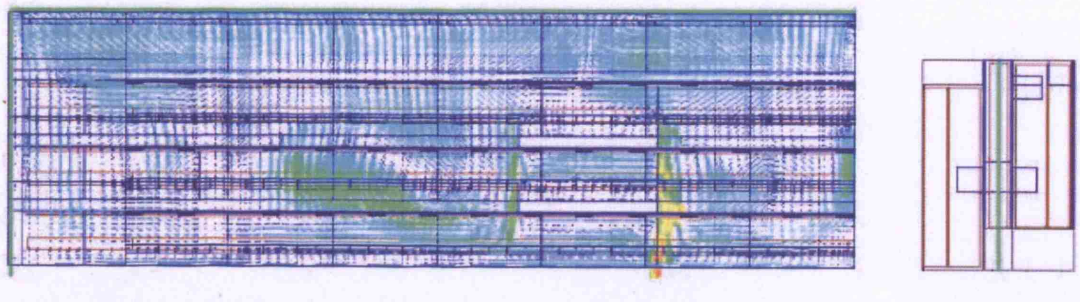


Fig 34. Thermal Model Mechanical Ventilation Long Section

5.06 Sensor Readings

Summer

The office was having an ongoing problem with the automatic window system when the sensors were in place from mid to late June. So the readings are only indicative of how the fabric is working and the relationship between the various zones of the building in terms of relative humidity (RH) and temperature. Even so the readings are surprisingly instructive. A full record of the readings is enclosed in Appendix G with key plans.

Generally the comments of the staff were confirmed the building is slightly warmer the further you progress up through the building and the southeast side is warmer than the northwest. The hours of working can easily be discerned from all the temperature graphs with five clear peaks in the week. At the weekend the RH soars and the temperature becomes very stable without the heat input from the occupants. The temperature swing through the day is fairly consistent throughout the building the troughs and peaks tend to be more extreme in the depth of the building. This would confirm the occupant comments on thermal comfort and the thermal modelling of the building showing static air inboard allowing heat and RH to build up. This effect is shown clearly on graphs F &G on the first floor.

The building has no humidity control beyond the effect of the fabric this is seen in the readings with the RH mirroring the temperature through the day. So in the morning the RH is a healthy 40% and as the building warms up it becomes a less healthy 30% which is outside the CIBSE Guide A recommendations of 40-70%. This process is more exaggerated on the warmer side of the building it would be healthier to work on the cooler side.

The most pertinent results were from the roof. The separate microclimate created by the chiller plant enclosure on the roof is revealed with the sensor readings. This shows how important it is that the external sensors for the building are located correctly as they could give distorted readings. The stability of the temperature and RH sensor located in the plant enclosure compared with the other sensor away from the plant areas could not be starker.

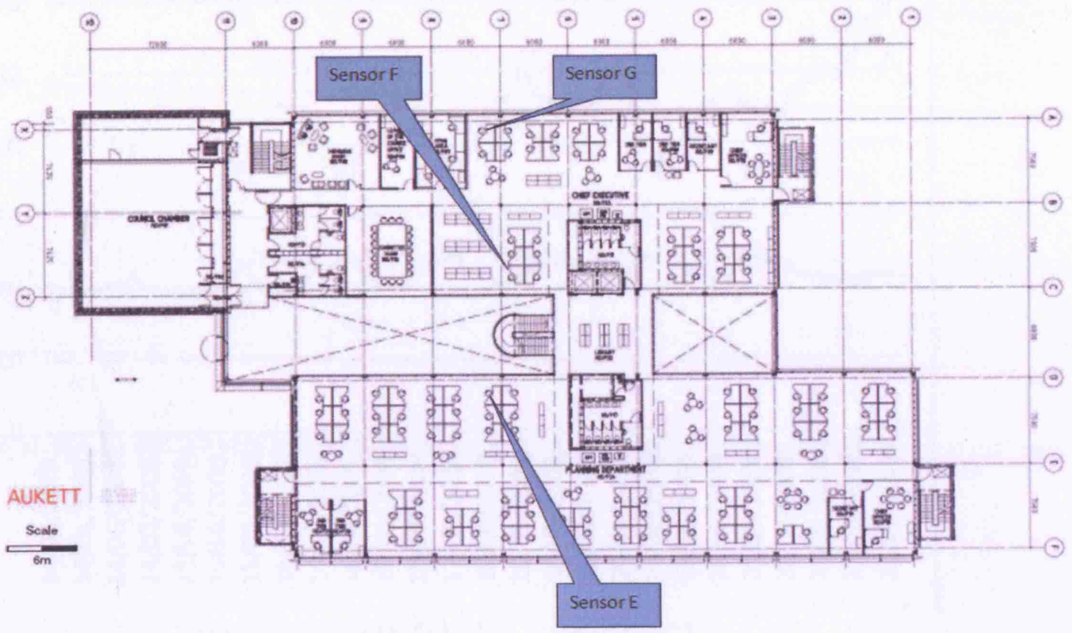


Fig 35. Key Plan: Summer First Floor

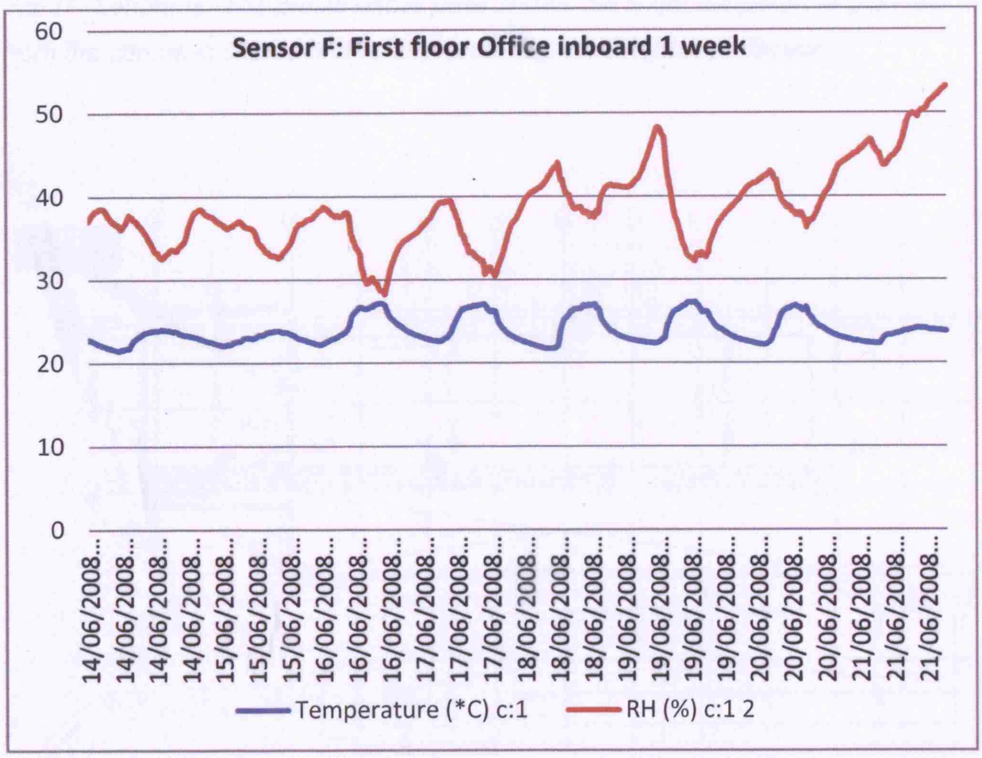


Fig 36. Sensor F: On the sunny side of inboard the temperatures are higher. The cooling has started at 25˚C but it is not coping with the temperature gain inboard.

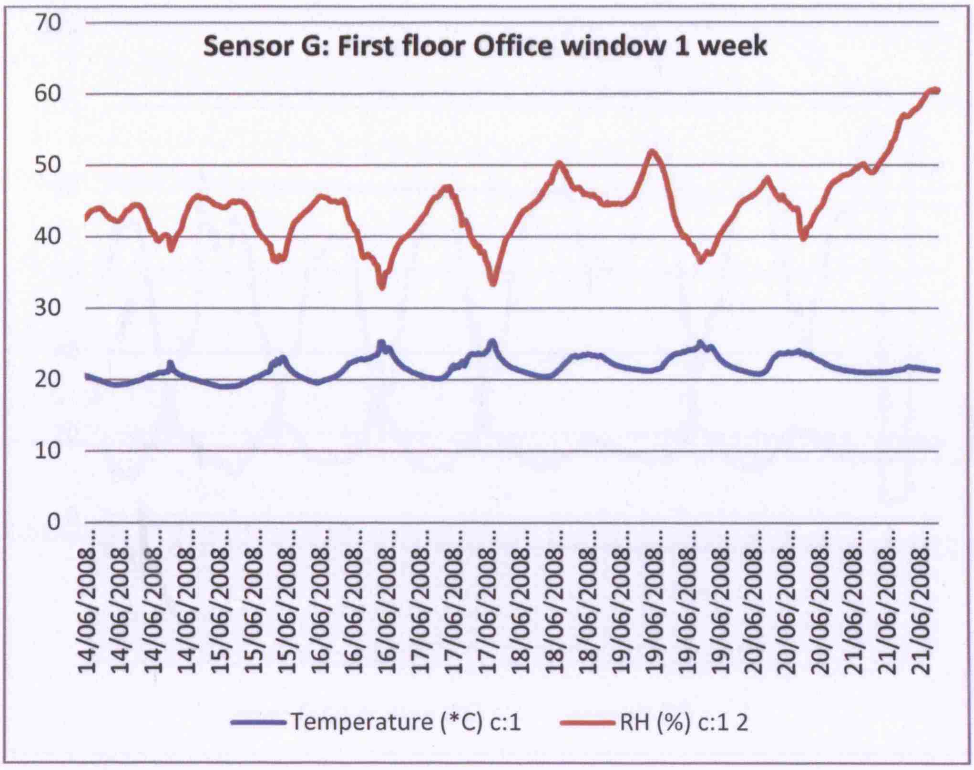


Fig 37. Sensor G: The profile of the peak shows the slight temperature gain late in the day from the sun as is shines on ***the unprotected on the northwest façade***

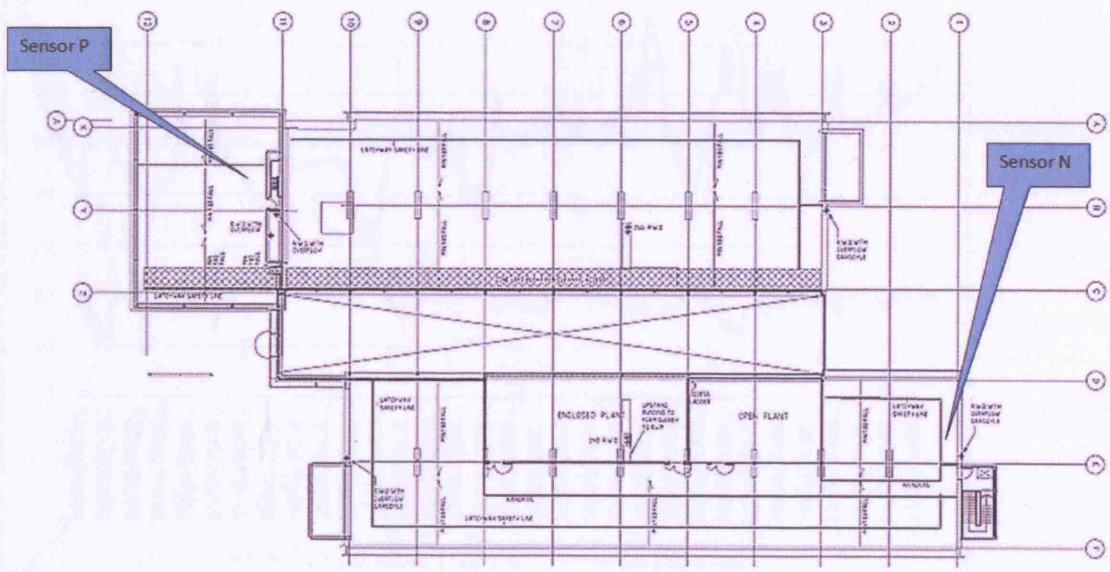


Fig 38. Key Plan Summer Roof

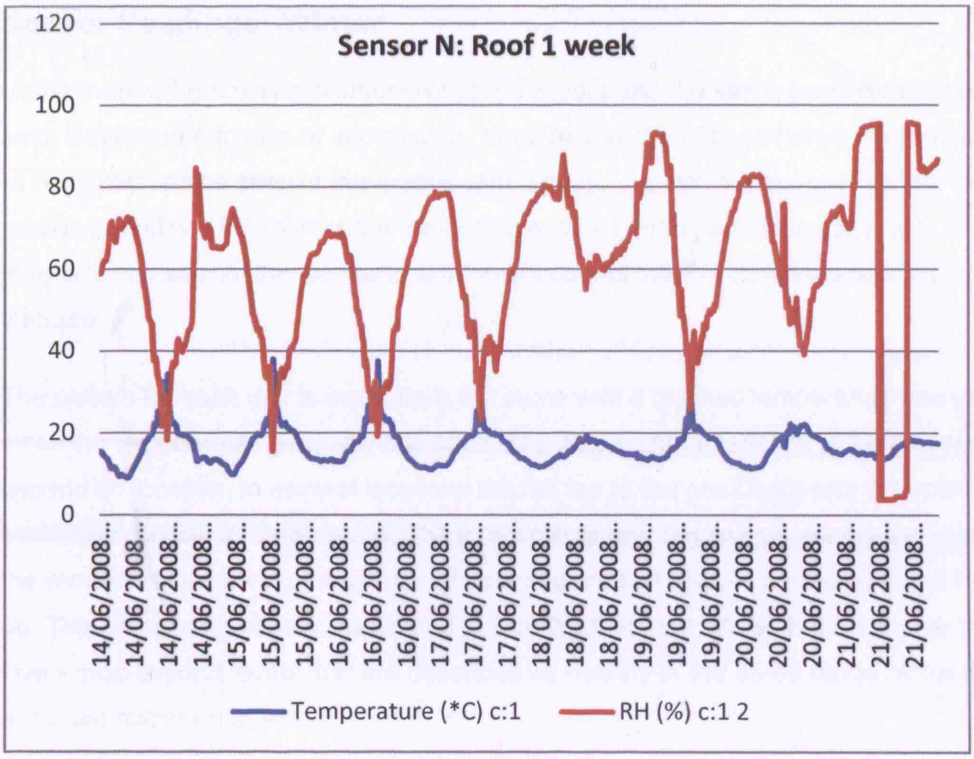


Fig 39. Sensor N: The wild fluctuations reveal the external location. The sensor was sheltered under a roof coping the high spike on the temperature indicates solar gain.

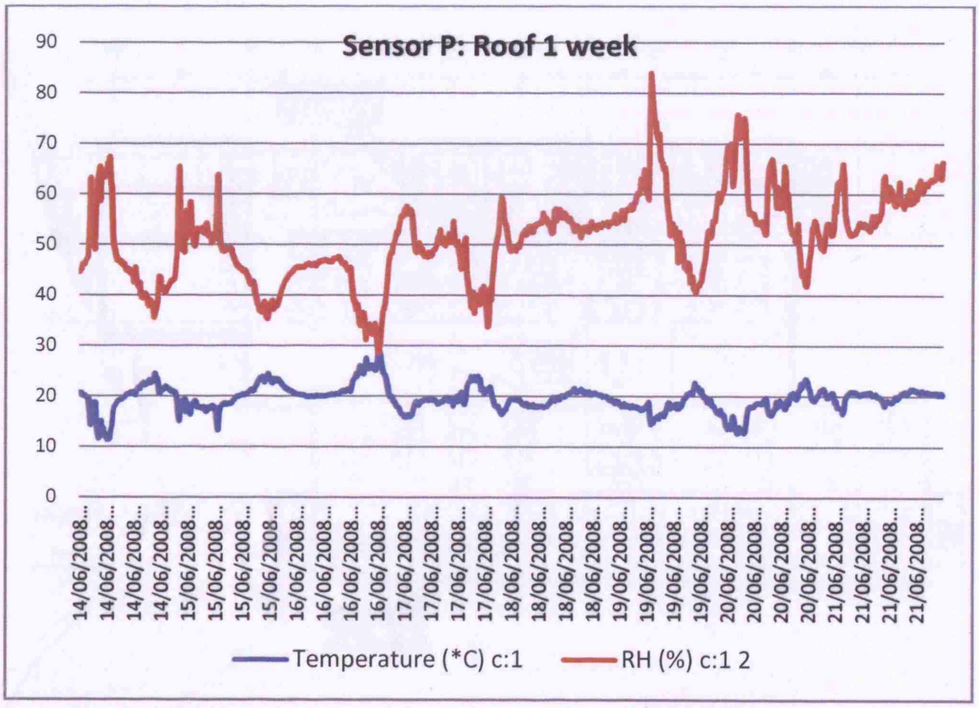


Fig 40. Sensor P: Located in the chiller enclosure which is sheltered but open to the elements the contrast with the other external sensor could not be starker. The enclosure with the heat gain from the chillers has its own microclimate.

Sensor Readings: Winter

Unfortunately there was a problem with the sensors and the same week cannot be used for each location due to loss of information. Nonetheless the data gathered is informative. Each working day can be seen in the graphs with a peak. As with the summer sensor data the relative humidity (RH) mirrors the temperature levels during a working day; with RH falling as temperature rises. At the weekend with no occupants the RH increases and the temperature stabilises.

The pattern for each day is essentially the same with a gradual temperature rise until midday when the temperature gradually subsides. The actual characteristics of the rise and fall depend on location. In several locations the flat top to the peak suggests the cooling is working at too low a temperature. The temperature and RH swings are greater inboard than the window side showing the effects of better ventilation dispersing the heat and RH build up. This shows with sensor readings 3 & 4 on the first floor. As with the summer the RH levels drop beyond levels that are described as healthy in the 25-30 range below the accepted minimum of 40%.

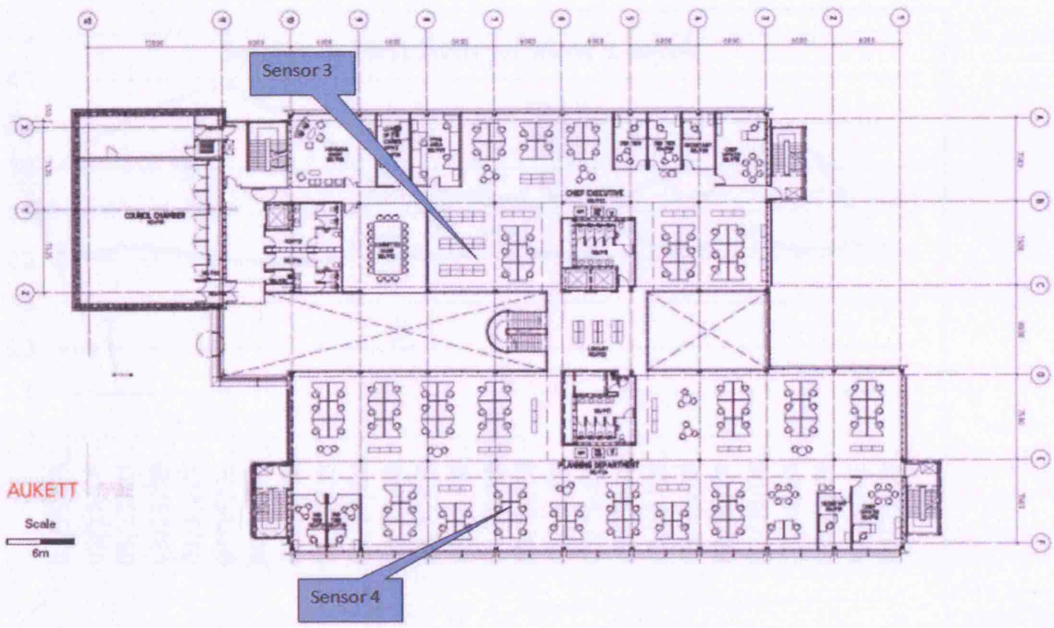


Fig 41. Key Plan: First Floor

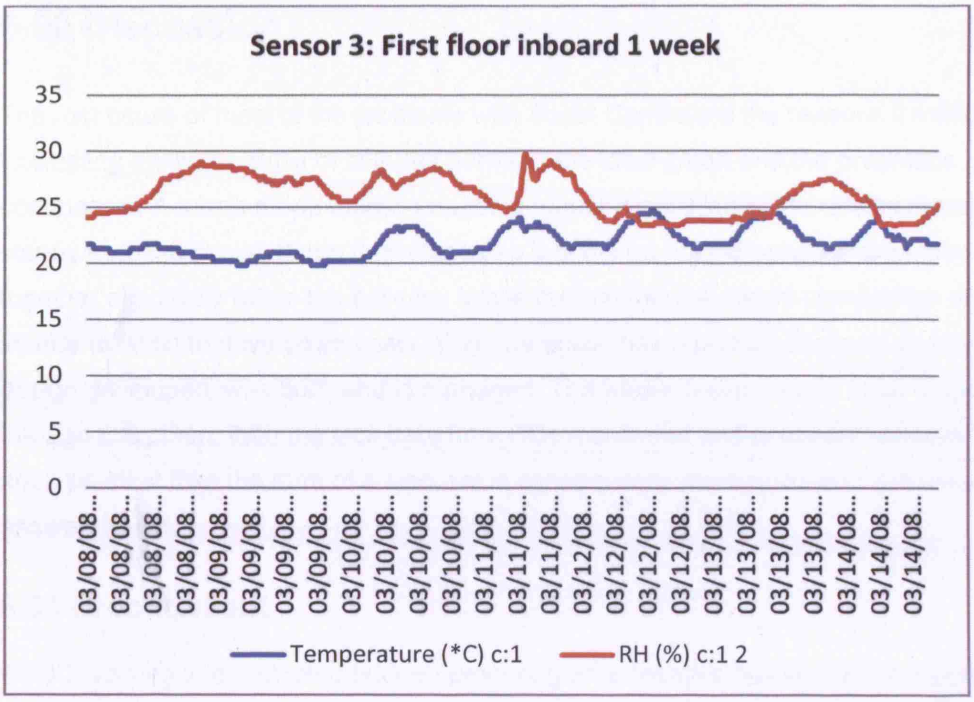


Fig 42. Sensor 3: Saturday-Saturday the temperature swings are more extreme inboard in the range of 5˚C. The location will have solar gain from the low sun of the glazed entrance which explains the steep rise in temperature each morning. The flat top to the peak on Monday and Tuesday indicates the cooling working at 23˚C

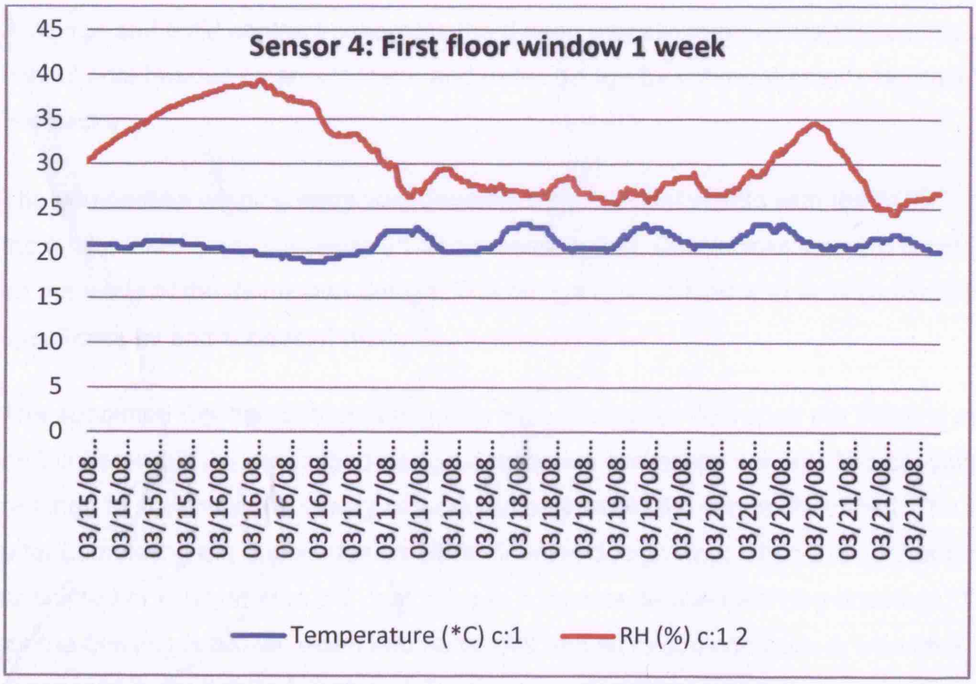


Fig 43. Sensor 3: Saturday-Saturday the temperature swings are more muted than the inboard readings again it looks as though the cooling is working at 23˚C, rather than the designed 25˚C from Monday to Thursday with a distinct flat top to the temperature peak.

6.00 Discussion

The root cause of most of the problems with South Cambs are the reasons it makes an interesting study the clash of cultures between the ideal green and the pragmatic commercial. A mixed mode building needs a robust integration of the design throughout all stages from the design to the final stages so that the fabric and services are tuned to work together effectively within the building. While the commercial needs competition and standardization to drive down costs. This interaction has a profound impact on how the design developed, was built, and is managed. The whole design needs to be looked at through this prism. With the lack data from CO_2 monitoring and occupant surveys, the analysis must take the form of a discussion consequently more questions are asked than answers given.

6.01 Procurement

SCDC working to a restricted budget, procuring an innovative building and concerned about rate payers 'value for money' used a limited 'turnkey' design competition. This ring fenced the cost of the project and ensured the quality of the design as Council offices. 'Turnkey' is a design and build contract where the whole building is supplied including the furnishings. The broad effect of a design and build contract is to emphasise time and cost at the expense of quality.

A design and build contract separates the design process into two stages; outline design by consultants headed by an architect; and detail design by sub-contractor's headed by a main contractor.

The competition winning entry was developed by the consultants with the SCDC to achieve the sustainable aims of Agenda 21 and breeam rating. Contractors then bid for the contract on the basis of the developed design. The design is described with arrangement drawings, specifications and scopes of work.

The appointed Contractor then assumes responsibility for delivering the building on time and on budget within the prescribed design description and scope set out. The consultants are retained to supervise the quality of work but only within the scope described. The architect after completing the outline design either finishes design work when the contractor is appointed or is novated to the contractor to complete detailed working drawings. The work for the building is broken down into packages and let to sub-contractors who take responsibility for detailed design, delivery and performance within the 'price'. The idea is to use the sub-contractors expertise in building to provide a cost effective product.

It is the last item which is the contentious part of the contract. The subcontractor in bidding for the work reduces profit margin. Having attained the work the contractor looks to regain profit by either altering the detail design to make it simpler to build or reducing the quality of the work done to speed the build. This process is well known and can be controlled with standard build items of known quantities and qualities. However specialist work of a more uncertain scope needing late changes and a high attention to detail can be open to abuse.

The design under the second phase of the contract is under the control of the main contractor whose interests are delivery of the building within the price and on time. The quality and detail control is from the consultants ensuring the work is done to the described specification, drawing or scope of work. Late design amendments by the consultants can only be done at a premium cost determined by the subcontractor if outside the scope of works. So in effect with a restricted budget late changes are almost unknown. [66]

6.02 Background

As general background it is clear from comments by Peter Eaton, Anna Lumsden and Phil Craig that the contractor McAlpines had difficulties managing the project. Typical examples being: Anna noting that the steelwork for the building arrived on site for erection before the actual drawings had been approved by the architects; Peter stating that four separate contracts had been let for the wiring on the building: and Phil saying there had not been enough time or budget to move an incorrectly placed sensor.

6.03 Mixed mode ventilation

The influence of the contract can be seen with the development of the design of the mixed mode ventilation system. The initial concept sketches show the use of the displacement ventilation system to make sure the whole floor plate has fresh air. Similar in concept to the Barclay card Headquarters by Fitzroy Robinson shown in the literature review. This is changed in the design development to using two entirely separate systems with a natural ventilation mode during temperate weather and conventional air-conditioning mode during temperature extremes. Finally the natural ventilation system is simplified still further with the use of a high level proprietary automatic window ventilation system.

The drive for this design development was the need to be able to divide the work into two relatively conventional packages an 'off the shelf' proprietary automated window system and normal displacement ventilation. This standardization enabled the contractor to obtain a competitive quotation for the work and allowed the services consultant to describe the ventilation system within familiar standards for air-conditioning and natural ventilation.

The effect of these changes to the design compromises the performance of the natural ventilation system. From the visits to the building it was evident that the occupants in reception and inboard on the floor plate were more prone to headaches and stuffy air later in the day. Reception had frequently asked for the front door to be left open to refresh the air. Both zones, in effect, receive second hand air from the perimeter automatic windows.

The effect of static air in these areas is confirmed with the thermal and CFD modelling of the section of the building. The sensor readings throughout the building show the inboard hobo's having discernibly higher temperature ranges and relative humidity swings than the window side. The more vigorous ventilation on the window side has dispersed the temperature and RH build-ups.

The rule of thumb in the CIBSE AM10 Guide for natural ventilation is that the maximum distance across the floor plate is five times the floor to ceiling height South Cambs is at the limit of these recommendations. [67] However these recommendations assume conventional windows. At South Cambs you have a high input and a high output so the ventilation does not gain from the buoyancy effect of the fresh air starting at a lower level and rising across the floor plate refreshing the air in the inhibited zone. Conversely the high input and output is ideal for night-time cooling. This problem needs more investigation in the building.

The existing configuration of the mixed mode ventilation system allows it to work in two modes at any one time so the minimum fresh air could be supplied through the displacement ventilation system whilst in natural ventilation mode. So the occupants of the inboard zone would receive enough fresh air.

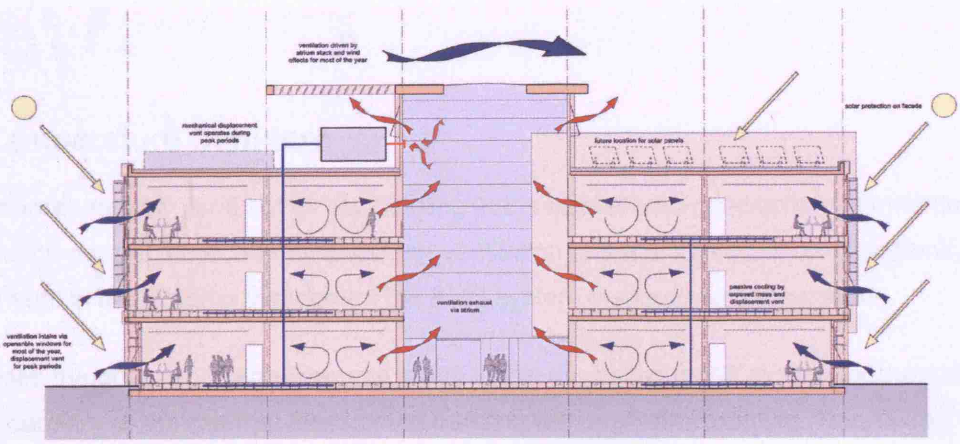


Fig 44. First Sketch Section showing concern about inboard air movement

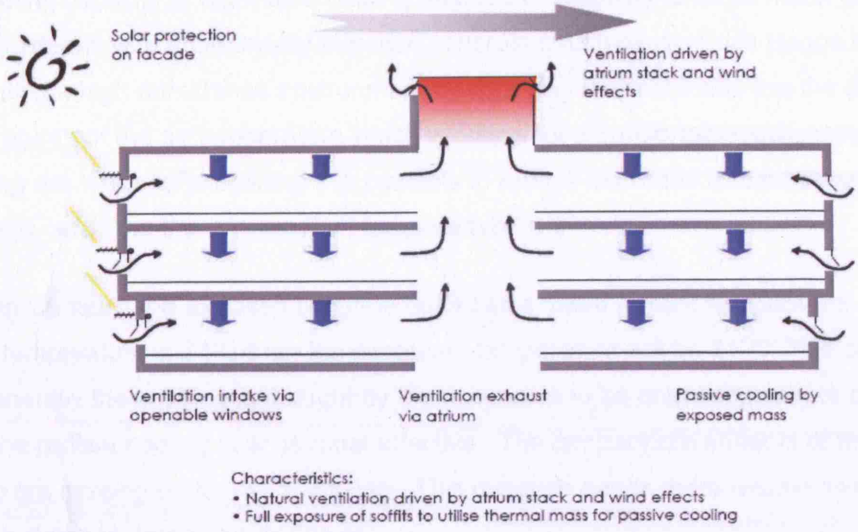


Fig 45. Ventilation from perimeter windows alone

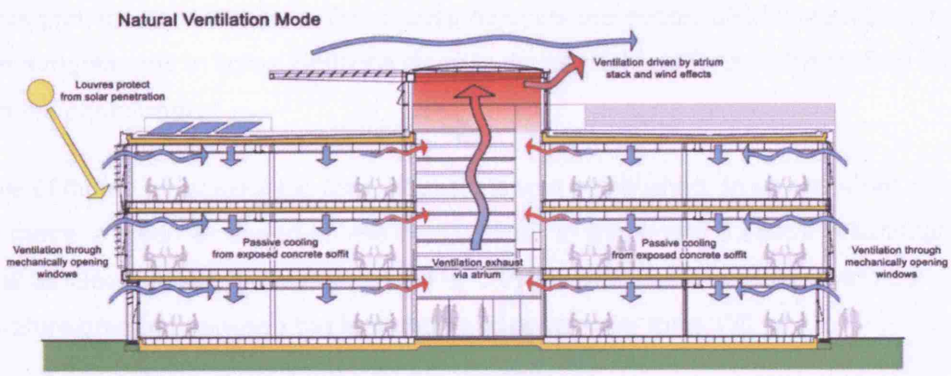


Fig 46. Ventilation from high perimeter windows even graphs do not show fresh air movement in inhabited zone.

6.04 Temperature Standard

The temperature standards set for the building in the brief are air-conditioning standards. The Council wanted the economy of natural ventilation and the comfort of air-conditioning. The sensors in the building that control the BMS system measure air temperature.

This raises the question is an allowance made within the mixed mode system for the radiant cooling capacity of the thermal mass of the building with night-time cooling. This 'coolth' is emitted as electromagnetic radiation which will not be measured by air temperature sensors. [68]

The cooling capacity of night-time cooling has been measured to be as much as 3˚C by Maria Koliteroni with an internally exposed concrete structure. [69] Clive Beggs has noted that by creating a high admittance environment by exposing thermal mass it is the dry resultant temperature not the air temperature which is critical for a comfortable environment. ***"By exposing the 'mass' of a building it is possible** to reduce the mean radiant temperature within **the space, and thus the dry resultant temperature."*** [70]

In South Cambs if the exposed concrete soffit has a mean radiant temperature of 18˚C and the air temperature is 24˚C then the perceived temperature will be 21˚C. This could explain why generally the building is thought by the occupants to be cold especially in the morning when the radiant cooling is at its most effective. The temperature sensors of the BMS system are missing up to 3˚C of cooling. This question needs more examination in the actual building to determine its validity.

6.05 Displacement Ventilation air input

The most thermal discomfort for the female occupants of the building was caused by the cold draughts from the floor diffusers. The circular diffusers are evenly distributed across the floor plate in a regular grid in some locations close to the seated positions of the staff as can be seen in the photograph.

The rule of thumb for positioning floor diffusers is well established. In an office not closer than 1 metre, a mean air speed of less than 0.15m/s in winter and 0.25m/s in summer, the input air temperature not lower than 18˚C (19˚C in the CIBSE AM13 Guide), and the temperature gradient between the feet and head not greater than 3˚C. [71]

Clearly the main problem with South Cambs is the positioning of the floor air terminal devices (ATD). A better positioning would have been along the circulation routes away from the desk positions.

The discomfort felt by the occupants in the office when the building is in cooling mode may also be due to the vertical temperature gradient air input to head height. The air temperature at which the cooling system is activated is 25˚C whilst the input is at 18˚C so the temperature gradient could be in excess of 3˚C explaining the discomfort felt by the occupants.

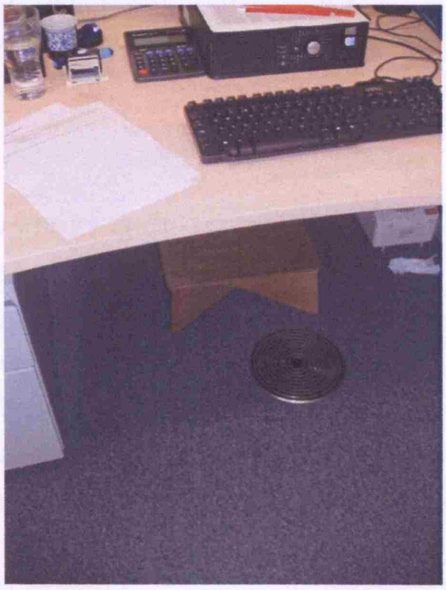


Fig 44. An example of a problem ATD

It would be possible to introduce the cooling air at a higher temperature and allow the general air temperature to reduce at a slower rate. An adaptive control algorithm (ACA) relating external temperature to internal temperature could be used to control the input temperature and reduce the thermal shock of **the cooled air from the ATD's and save** energy.

6.06 Sensors

The poor control of the subcontractors on site can be judged with the sensor positioning. The main external temperature control sensor is located in the chiller enclosure on the roof. The hobo monitoring this area compared with another hobo on the roof shows it to have an entirely separate microclimate to the outside. This would completely distort the readings for the BMS control system. This is symptomatic of the lack of control of the various contractors on site by the main contractor which was not noticed by the services consultant.

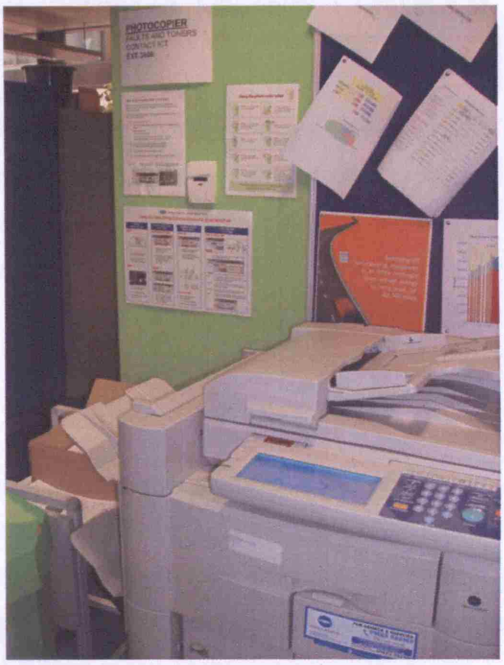


Fig 45. Temperature sensor on wall with notices next to photocopier

A similar problem occurred on the floor plate with the temperature sensors being located next to the photocopiers and printers. Although the heat output from modern machines is far less than before it is bad practice.

6.07 Air Stratification

In natural ventilation mode the heat builds up in the top floor by the end of the day this was causing discomfort. The thermal modelling done for the building clearly shows that this is likely to occur with the heat build up in the lantern spilling into the adjoining top floor. This could be simply rectified with a sensor simply opening the extract windows enough to spill the unwanted heat. The Architect Adam Mathews noted that Faber Maunsell had latterly shown some concern about the free area of windows needed in the lantern. It was found that the sub-contractors drawings had reduced the openable area as a cost saving this needed a late alteration.

6.08 Design Team

The professional fees for design and build are not generous being subject to competitive bid. Both Aukett and Faber Maunsell made no profit from South Cambs because the input demanded of an innovative building with the extra problems it generates absorbed the fee. Aukett the architects with problems of quality control in the build and Fabers with the post completion problems of relating the BMS to the automatic window system.

6.09 Facilities Management

The adage from the Probe studies is "don't procure what you can't manage" is very true of South Cambs. [72]

The consequences of the procurement method can be seen with no single point of responsibility that the Management of South Cambs can address to deal with the problems with the building. Most recently a tragic comic situation occurred when the automatic windows in the lantern were not working correctly. South Cambs found the various sub-contractors blaming one another but with nobody taking the responsibility for resolving the problem. The consequence was a large electric bill for running the AC system for a month to keep the Council offices habitable.

South Cambs themselves have not devoted enough management resources to what is a complex fragile innovative building. The running of the control software for the BMS has been outsourced and is remotely controlled. More pertinently the facilities management has been recently resourced as a part-time role in the office this allows problems to accumulate. With the advent of the recent difficulties with the building these problems have been acknowledged and the issues are beginning to be addressed.

6.10 Energy Use

With the aforementioned catalogue of 'issues' **with** the building it is not surprising that its energy use is comparable to an air-conditioned office. All the problems in the building are resolvable with the correct support and advice. An example of this is illustrated with the Wessex Water Headquarters by Bennett Associates. The first year energy figures for the building were disappointing, exceeding the predictions. The Architects policy of revising the building to review its use helped resolve the problems; due chiefly to the staff not using the building as the designers had intended. The second year energy figures matched the predictions. [73]

7.00 Conclusion

At the outset it needs to be stated that South Cambs should be applauded for the courage and foresight to commission a low energy building on a restricted budget.

So how have South Cambs after starting off with the sustainable ideals of subscribing to Agenda 21 finished off with a slightly uncomfortable malfunctioning building which consumes as much energy as any standard air conditioned office?

Simply they choose the wrong vehicle for procurement design and build emphasises time and cost at the expense of quality. The prerequisite for a mixed mode building to work is a close integration of the fabric and services and a high input from the designers to make it work effectively. This demands quality of time and effort. The standard for design and build is the minimum set by regulation or performance for cost efficiency.

The reality of South Cambs is that after setting off with the highest of ideals the development of the design and standard of the building was suborned to the demands of value for money which is the intent of the contract. The consultants had neither the time or budget to impose the intellectual rigor needed for a building of this type hence the retreat to familiar methods and proprietary systems. Future low energy offices built to a restricted budget need the support of exacting energy performance standards which are imposed by legislation. These standards need to be ongoing so the performance of the building is maintained during its use and not neglected by management. The Energy Performance Certificates hopefully mark the start of this process.

South Cambs needs an energy audit by an outside body. This would help the management regain faith in the essential soundness of t**he building's design. The audit would establish** where the problems are with the building and how they can be corrected. The energy saved in the buildings operation and the benefit to the thermal comfort of the occupants should more than justify this process to the management.

In conclusion South Cambs is not the sustainable model for a future low energy commercial office. It is a valuable lesson in how the process of procuring a building is as important as the intent of the design itself. South Cambs have travelled apart of the journey towards a low carbon future. Commercial offices with the financial imperative of profit need the limits imposed by regulation so energy standards can be enforced. High ideals are not enough.

References

1. UKCIP08, 2007. Jenkins, G.J. Perry, M.C., and Prior, M.J.O. *The climate of the United Kingdom and recent trends.* Met Office Hadley Centre, Exeter, UK.
2. Schellnhuber, H.J. (ed), 2006. *Avoiding Dangerous Climate Change.* Cambridge University Press.
3. IPCC, 2007. *Climate Change 2007: Synthesis Report.* Contribution of Working Groups I, II and III to the Fourth Assessment. Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland, 104pp.
4. Defra Publication, 4th April 2008. *Climate change and energy.* UK Legislation: taking the Climate Change Bill **forward – progress.**
5. www.berr.gov.uk/sectors/construction/ConstructionStatistics
6. Leggett, J. 2005. *Half Gone: Oil, Gas, Hot Air and the Global Energy Crisis.* Portobello Books Ltd.
7. Carbon Trust, March 2007. *Air conditioning: Maximising comfort, minimising energy consumption.* CTG005 Technology Guide.
8. The Chartered Institution of Building Services Engineers, February 2005. *Climate change and the indoor environment: impacts and adaption.* CIBSE TM36: 2005.
9. Bordass, W. 2007. *Energy Performance. In: Sustainable Architecture.* Edited by David Turrent. RIBA Publishing.
10. The Chartered Institution of Building Services Engineers, 2000. *Mixed mode ventilation. CIBSE Applications Manuel AM13*: 2000.
11. Daines, E. and Mathews, A. 2004. ***Aukett's sustainable exemplar: South** Cambridgeshire District Councils hq.* A.EcoTech: Sustainable Architecture Today. Issue 9. P38-43
12. Robson, C. 1993. *Real World Research: a resource for social scientists and Practitioner-researchers*, Blackwell, London. P 40-41&4.
13. IPCC, 2007: *Climate Change 2007: Synthesis Report.* Contribution of Working Groups I, II and III to the Fourth Assessment. Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland, 104pp.
14. Schellnhuber, H.J. (ed), 2006. *Avoiding Dangerous Climate Change.* Cambridge University Press.
15. UKCIP08, 2007. Jenkins, G.J. Perry, M.C., and Prior, M.J.O. *The climate of the United Kingdom and recent trends.* Met Office Hadley Centre, Exeter, UK.
16. National Oceanic and Atmospheric Administration, 2008. *Carbon Dioxide, Methane Rise Sharply in 2007.* NOAA. 23rd April 2008.

17. IPCC, 2007. *Climate Change 2007: Synthesis Report*. Contribution of Working Groups I, II and III to the Fourth Assessment. Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland, 104pp.
18. Meacher, M. 2007. The Guardian. Blitz spirit needed to face threat of climate change. Wednesday 9th May.
19. The Chartered Institution of Building Services Engineers, February 2005. *Climate change and the indoor environment: impacts and adaption. CIBSE TM36*: 2005.
20. The UKCIP02 Scientific report. 2002. Hulme,M., Jenkins,G.J., Lu,X., Turnpenny,J.R., Mitchell,T.D., Jones,R.G., Lowe,J., Murphy,J.M., Hassell,D., Boorman,P., McDonald,R. and Hill,S. Climate *Change scenarios for the United Kingdom.* Tyndall Centre for Climatic Research, School of Environmental Sciences, University of East Anglia, Norwich, UK.
21. The Chartered Institution of Building Services Engineers, February 2005. *Climate change and the indoor environment: impacts and adaption. CIBSE TM36*: 2005.
22. UKCIP08, 2007. Jenkins, G.J. Perry, M.C., and Prior, M.J.O. *The climate of the United Kingdom and recent trends.* Met Office Hadley Centre, Exeter, UK.
23. The Chartered Institution of Building Services Engineers, February 2005. *Climate change and the indoor environment: impacts and adaption. CIBSE TM36*: 2005.
24. The UKCIP02 Scientific report. 2002. Hulme,M., Jenkins,G.J., Lu,X., Turnpenny,J.R., Mitchell,T.D., Jones,R.G., Lowe,J., Murphy,J.M., Hassell,D., Boorman,P., McDonald,R. and Hill,S. *Climate Change scenarios for the United Kingdom.* Tyndall Centre for Climatic Research, School of Environmental Sciences, University of East Anglia, Norwich, UK.
25. www.berr.gov.uk/sectors/construction/*ConstructionStatistics*
26. The Chartered Institution of Building Services Engineers, February 2005. *Climate change and the indoor environment: impacts and adaption. CIBSE TM36*: 2005.
27. Edwards, B and Bordass, W. 1997. *Brian Edwards on a major low-energy hq by Fitzroy Robinson.* Architecture Today July 1997 pp20-30
28. Saxon, R. 1980. *Atrium buildings: Development and design.* The Architectural Press.
29. The Chartered Institution of Building Services Engineers, 2005. *Natural ventilation in non domestic buildings. CIBSE AM10*: 2005.p18
30. Kathryn J. McCartney and J. Fergus Nicol. 2002. *Developing an adaptive control algorithm for Europe.* Energy and Building 34, 623-635.
31. Nicol, J.F. and Humphreys, M.A. 2002. *Adaptive thermal comfort and sustainable thermal standards for buildings.* Energy and Buildings 34, 563-572
32. Stoops, J.L. 2004. *A possible connection between thermal comfort and health.* Lawrence Berkeley National Laboratory, paper 55134
33. Kathryn J. McCartney and J. Fergus Nicol. 2002. *Developing an adaptive control algorithm for Europe.* Energy and Building 34, 623-635.

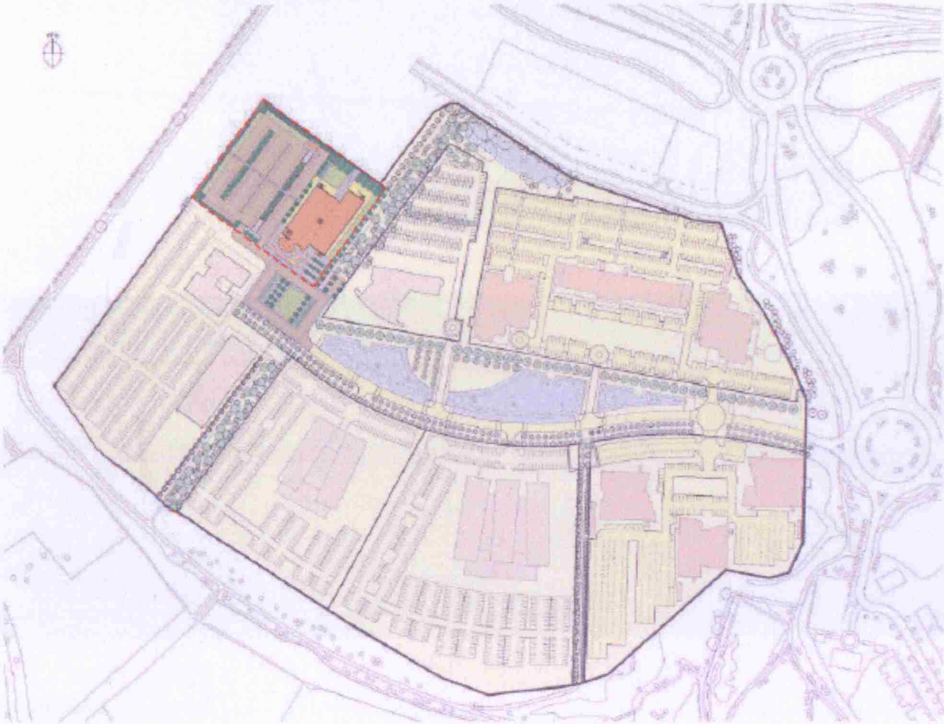
34. Leaman, A.J. and Bordass, W.T. 1997. *Productivity in Buildings: the Killer Variables.* Workplace Comfort Forum, London, UK.
35. The Chartered Institution of Building Services Engineers, 2000. *Mixed mode ventilation. CIBSE Applications Manuel AM13*: 2000.
36. Kathryn J. McCartney and J. Fergus Nicol. 2002. *Developing an adaptive control algorithm for Europe.* Energy and Building 34. 623-635.
37. Nicol, J.F. and Humphreys, M.A. 2002. *Adaptive thermal comfort and sustainable thermal standards for buildings.* Energy and Buildings 34. 563-572
38. Carmona, I. Bordass, W.T. and Leaman, A.J. 2006. *Post Occupancy Evaluation.* The Green building bible, volume 1 3rd edition Green Building Press. 190
39. Bordass, W.T. Derbyshire, A. Eley, J. and Leaman, A.J. 2004. *Closing the Loop, Post-Occupancy Evaluation: The Next Steps. Beyond Probe: Making Feedback routine.* Cumberland Lodge, Windsor, UK.
40. Carmona, I. Bordass, W.T. and Leaman, A.J. 2006. *Post Occupancy Evaluation.* The Green building bible, volume 1 3rd edition Green Building Press. 190
41. Bordass, W.T. and Leaman, A.J. 2004. *Closing the Loop, Post-Occupancy Evaluation. The Next Steps Probe: How it happened, what it found, and did it get us anywhere?* Cumberland Lodge, Windsor, UK.
42. Bordass, W.T. Leaman, A.J. Cohen, R. 2001. *Walking the Tightrope*, The Probe teams response to comments in BR&I. the Probe Team 2001.
43. Cohen R., Therberg I., Bordass W. and Field J. 2008. *Implementation of EPBD (Energy Performance Building Directive) Article 7.3 in Germany and the UK: Comparison of Methodologies and Procedures*, Improving Energy Efficiency in Commercial Buildings (IEECB) conference (IEECB '08), 10-11 April, 2008, Frankfurt
44. Bennetts, R., and Bordass W. 2007. *Keep It Simple And Do It Well.* Sustainability supplement to Building magazine. 28th September.
45. Leaman, A.J. 2004. *Outside the Comfort Zone: buildings and basic human needs.* Human Givens Journal, volume 11, No 2 2004.
46. Bordass, W.T. Leaman, A.J. Ruyssevelt, P. 2000. *Assessing building performance in use 5: Conclusions and implications.* The Probe Team.
47. Adrian Leaman. 2003. *Post-occupancy Evaluation*, prepared for Gaia Research Sustainable Construction Continuing Professional Development, Building Use Studies
48. Cohen R., Therberg I., Bordass W. and Field J. 2008. *Implementation of EPBD (Energy Performance Building Directive) Article 7.3 in Germany and the UK: Comparison of Methodologies and Procedures*, Improving Energy Efficiency in Commercial Buildings (IEECB) conference (IEECB '08), 10-11 April, 2008, Frankfurt

49. Adrian Leaman. 2003. *Post-occupancy Evaluation*, prepared for Gaia Research Sustainable Construction Continuing Professional Development, Building Use Studies
50. www.communities.gov.uk/planningandbuilding/theenvironment/energyperformance/publiccommercialbuildings/*displayenergycertificates*.
51. Adrian Leaman. 2003. *Post-occupancy Evaluation*, prepared for Gaia Research Sustainable Construction Continuing Professional Development, Building Use Studies
52. Robson, C. 1993. *Real World Research: a resource for social scientists and Practitioner-researchers*. Blackwell, London. P 40-41&4.
53. Bordass, W.T. and Leaman, A.J. 2004. *Closing the Loop, Post-Occupancy Evaluation. The Next Steps. Probe: How it happened, what it found, and did it get us anywhere?* Cumberland Lodge, Windsor, UK.
54. Adrian Leaman. 2003. *Post-occupancy Evaluation*, prepared for Gaia Research Sustainable Construction Continuing Professional Development, Building Use Studies
55. Daines, E. and Mathews, A. 2004. ***Aukett's sustainable exemplar: South*** *Cambridgeshire District Councils hq*. A.EcoTech: Sustainable Architecture Today. Issue 9. P38-43
56. *BCO Awards submission. 2005. South Cambridgeshire Hall* a development by Cambourne Business Park. Brochure for British Council for Offices.
57. Daines, E. and Mathews, A. 2004. ***Aukett's sustainable exemplar: South*** *Cambridgeshire District Councils hq*. A.EcoTech: Sustainable Architecture Today. Issue 9. P38-43
58. *BCO Awards submission. 2005. South Cambridgeshire Hall* a development by Cambourne Business Park. Brochure for British Council for Offices.
59. Daines, E. and Mathews, A. 2004. ***Aukett's sustainable exemplar: South*** *Cambridgeshire District Councils hq*. A.EcoTech: Sustainable Architecture Today. Issue 9. P38-43
60. Beggs, C. 2002. *Energy: Management, Supply and Conservation*. Butterworth Heinemann, P 204.
61. Craig, P. 2006. *Energy-Efficient Premises for SCDC*. Visionfm the inhouse magazine for Faber Maunsell.
62. Leaman, A. 2003. *Post-occupancy Evaluation*, prepared for Gaia Research Sustainable Construction Continuing Professional Development, Building Use Studies
63. Faber Maunsell Building Log Book South Cambs Hall 1/02/06
64. Carbon Trust, 2000. Energy Consumption Guide 19, Energy Use in Offices.

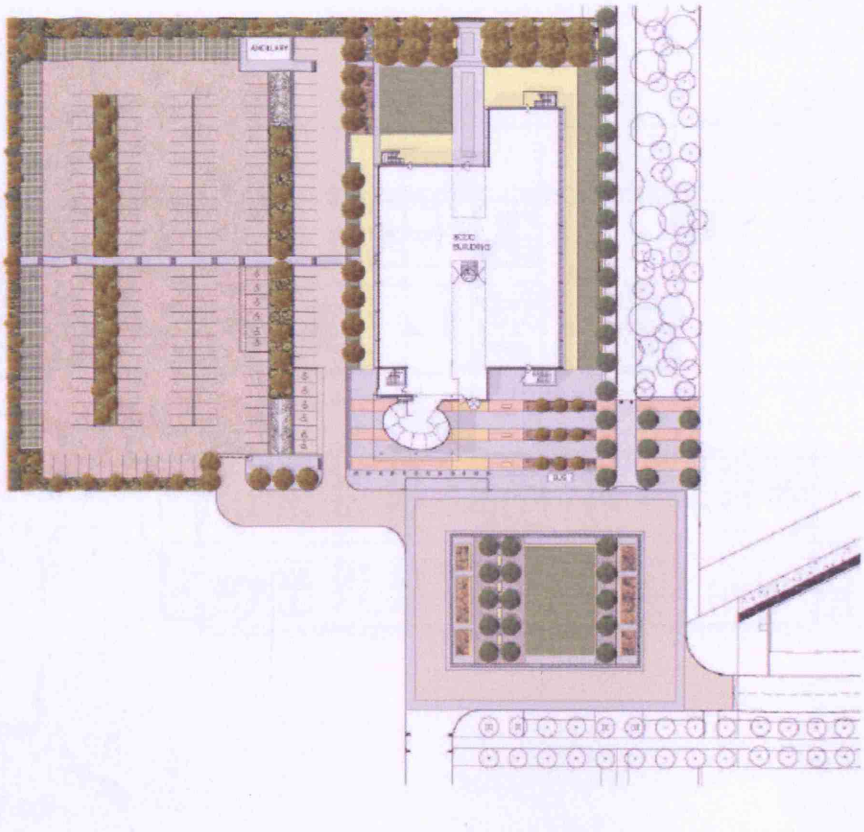
65. The Chartered Institution of Building Services Engineers, 2005. *Natural ventilation in non domestic buildings. CIBSE AM10*: 2005.p18
66. The Aqua Group. 1990. *Tenders and Contracts for Building*, 2nd ed. Blackwell Science Limited. P99
67. The Chartered Institution of Building Services Engineers, 2005. *Natural ventilation in non domestic buildings. CIBSE AM10*: 2005.p17
68. Watts, W.1996. Comfort, health and environmental physics. Environmental Design. Thomas, R.(ed). E & FN Spon. p11.
69. Kolokotrani M. 1998. Night ventilation for cooling office buildings. BRE IP 4/98.
70. Beggs, C. 2002. *Energy: Management, Supply and Conservation*. Butterworth Heinemann, P 204.
71. Abbas T. 1999. Displacement Ventilation and Static Cooling Devices. Code of Practice 17/99. The Building Research and Information Association (BSRIA).
72. *Bordass, W.T. and Leaman, A.J. 2004.* Closing the Loop, Post-Occupancy Evaluation. The Next Steps. Probe: How it happened, what it found, and did it get us anywhere? *Cumberland Lodge, Windsor, UK.*
73. Jones, W. 2008. *Bennetts Associates Wessex Water HQ reviewed*. Building Design 8th February

List of Figures

Appendix A: Building Drawings



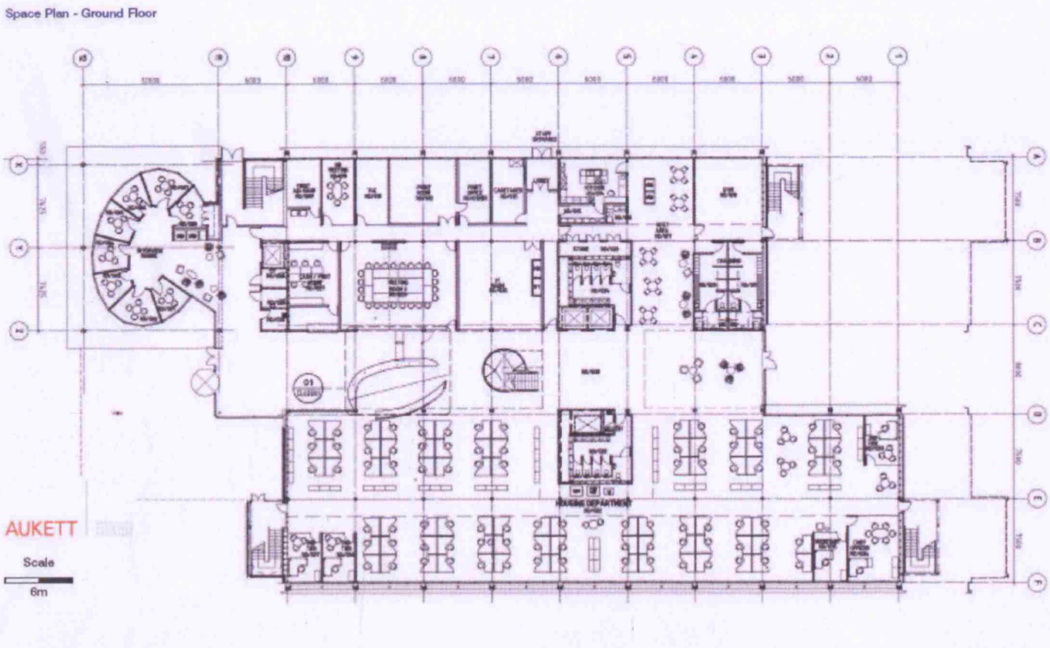
Location Plan



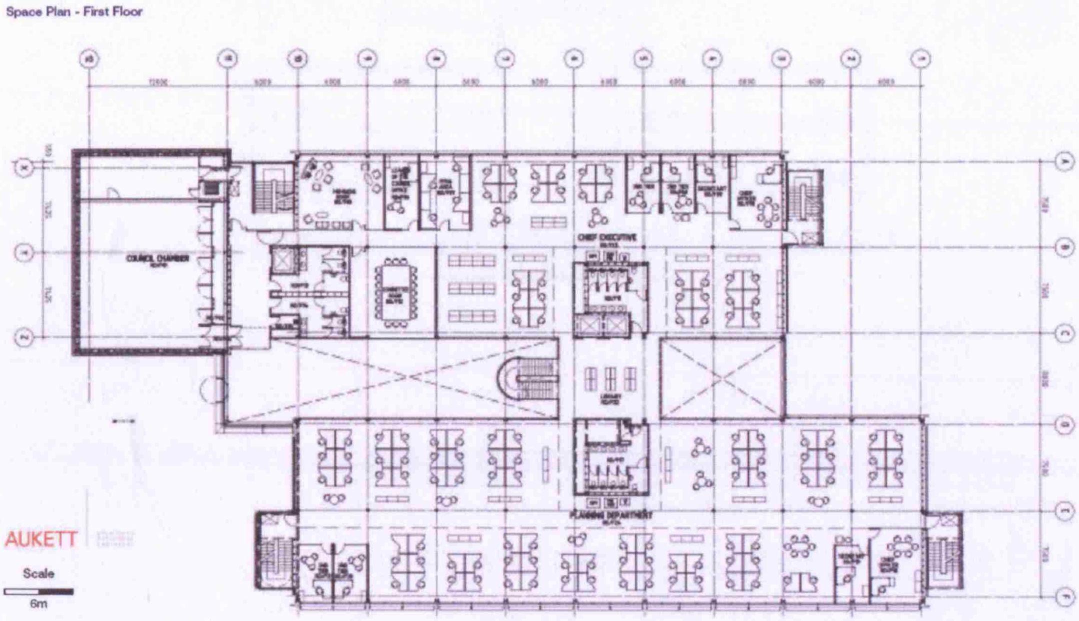
Site Plan

South west elevation

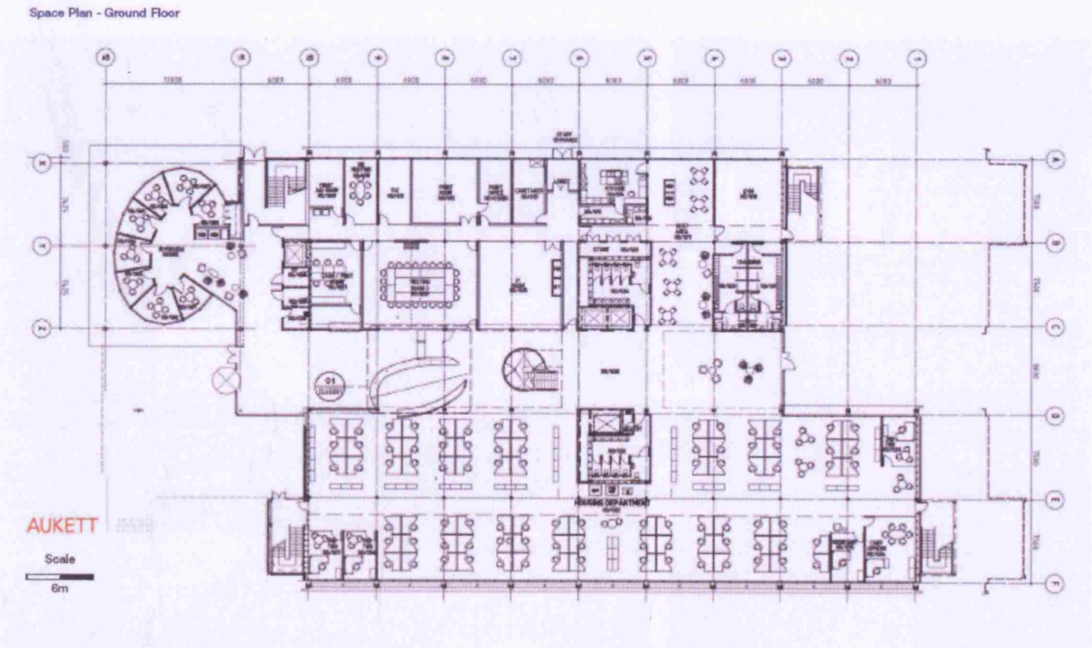
Elevations



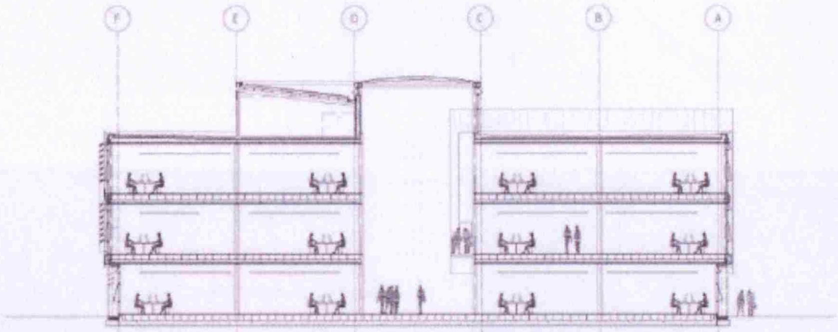
Ground Floor



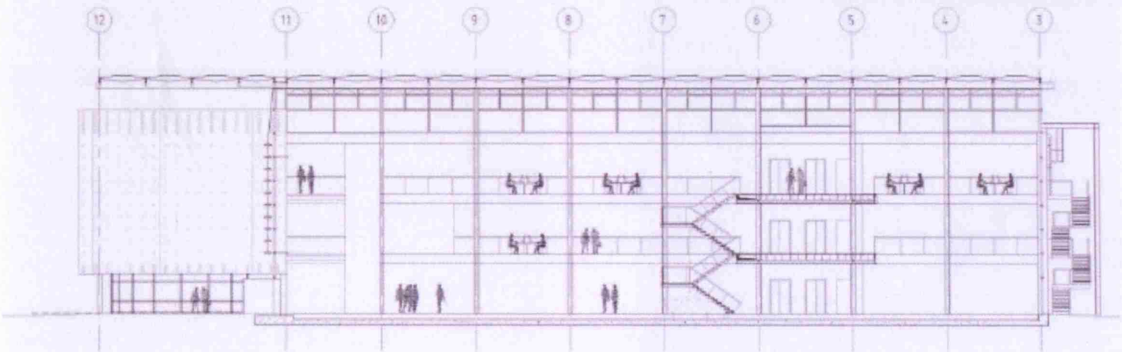
First Floor



Second Floor



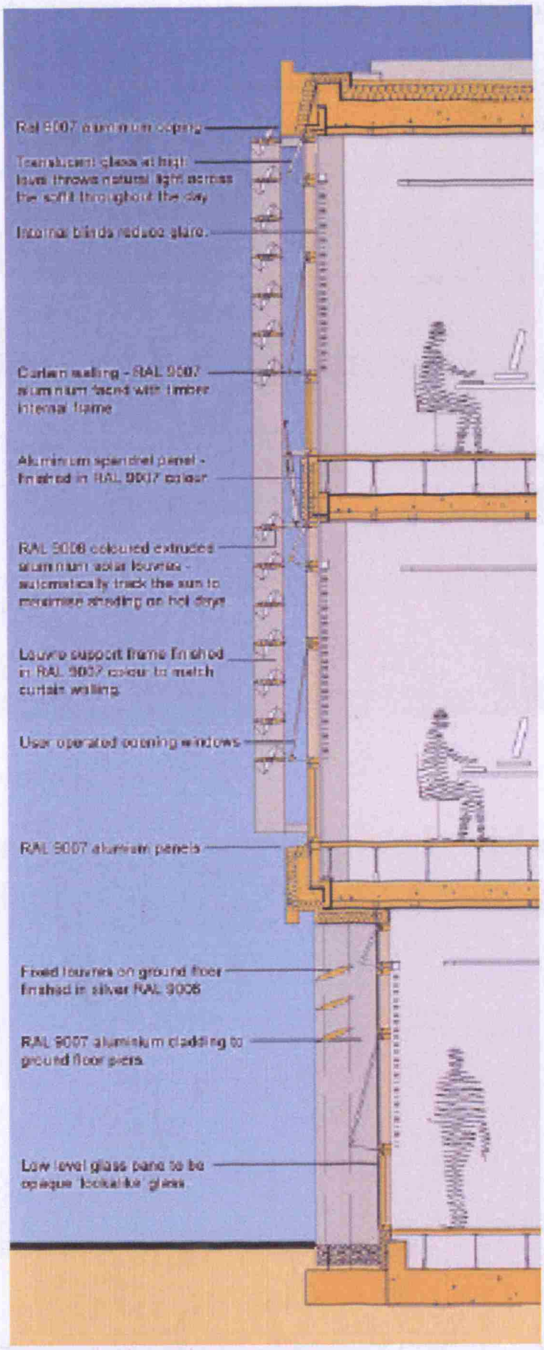
Cross section through street / offices looking south



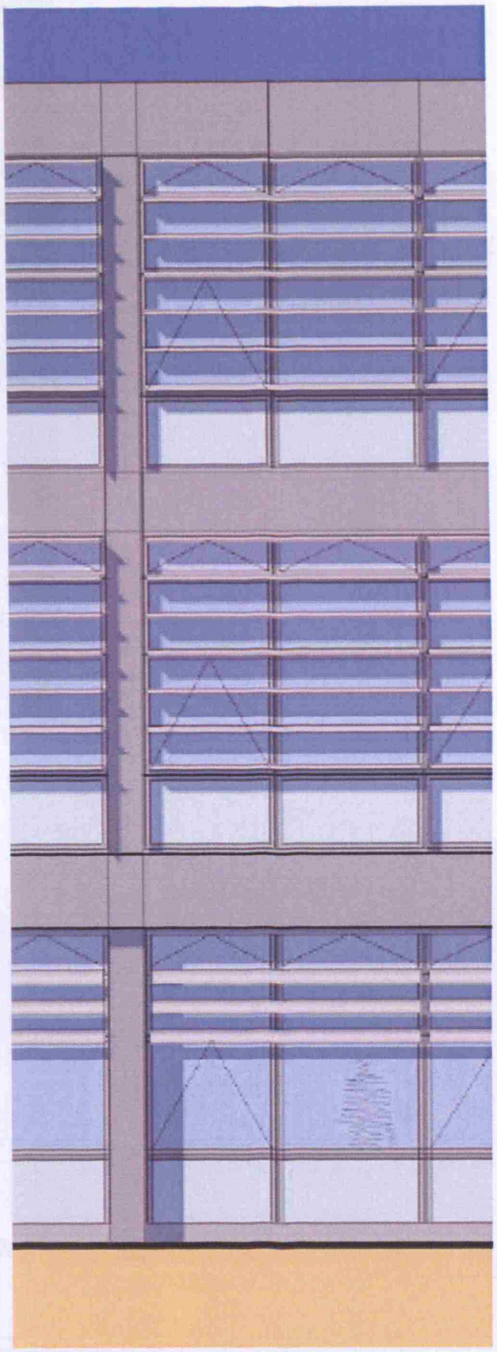
Long section through street looking west

Sections

Exterior Photos



Cross section through typical office facade

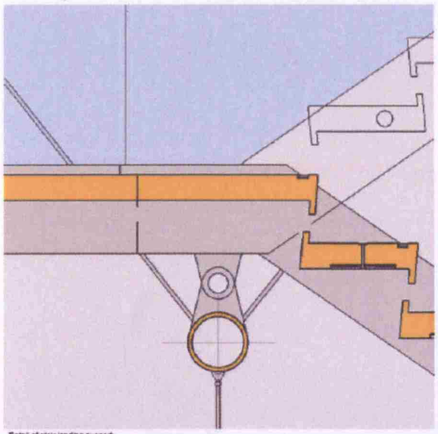


Part elevation of typical office facade

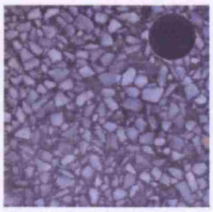
Part Section Elevation

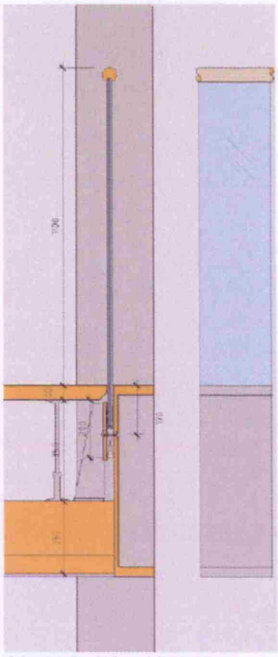
Inside

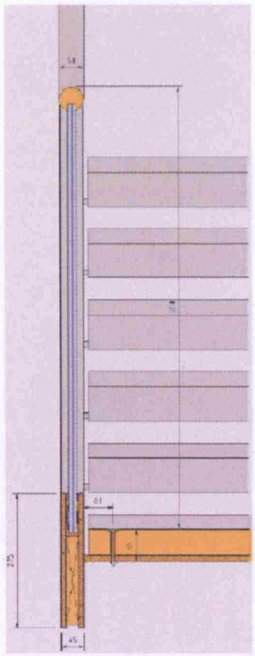
Outside


Detail of stair landing support


Terrazzo stair example


Terrazzo and carborundum sample


Section and elevation detail of glass balustrades to office areas


Detail section through stair balustrade

Stair details

Stair

Appendix A: Breeam

BUILDING RESEARCH ESTABLISHMENT
ENVIRONMENTAL ASSESSMENT METHOD

BREEAM 98 for Offices
Version 1.1

An environmental assessment for office designs

CERTIFICATION REPORT

Building :	**South Cambridgeshire District Council, Plot 6010, Cambourne Business Park**
Developer :	**Development Securities**
Date :	**17th April 2003**
Ref. No :	**28228ELE**
Assessors:	**Amy Garrod & Tom Randall**

FaberMaunsell
Sustainable Development Group
Tel : 020 7601 1652
Fax : 020 7601 1666
E-mail : tom.randall@fabermaunsell.com

Alterations
The BRE hold the right to update or alter the scheme at any time. FaberMaunsell as their agents will implement these changes to any assessment being undertaken.

QUALITY REVIEW
Report Prepared by: Tom Randall & Amy Garrod
Report Reviewed by: Amy Garrod
Date Reviewed: 16 April 2003

GENERAL DETAILS

Building:	**South Cambridgeshire District Council, Plot 6010, Cambourne Business Park**
Developer:	**Development Securities**
Architect:	**Aukett**
Building Services:	**FaberMaunsell**
Contractor:	**Alfred McAlpine**
Assessors:	**Amy Garrod & Tom Randall**
Ref.:	**28228ELE**

This assessment has been based on drawings and information collected at a meeting on the 22nd October 2002 at the offices of Development Securities, London and on information received subsequently. The following people attended the meeting:

Ian Pryor	**AYH Plc**
Ed Daines	**Aukett**
Graeme Bell	**FaberMaunsell**
Amy Garrod	**FaberMaunsell (BREEAM Assessor)**
Tom Randall	**FaberMaunsell (BREEAM Assessor)**

CONTENTS

ASSESSMENT SUMMARY

INTRODUCTION

The SCDC Office building has been assessed using BREEAM 98 for Offices Version 1.1, the Building Research Establishment Environmental Assessment Method for New and Existing Office Designs. Details of the method are set out in the 'BREEAM 98 for Offices'[1] publication.

This report describes the performance of the building at certification.

BREEAM 98 for Offices seeks to minimise the adverse effects of new buildings on the environment at global and local scales, whilst promoting healthy indoor conditions for the occupants. The environmental implications of a new building are assessed at the design stage, and compared with good practice by independent assessors.

An overall rating of the building's performance is given using the terms Pass, Good, Very Good or Excellent. This is determined from the total number of BREEAM criteria met and their respective environmental weighting. An explanation of the rating system for BREEAM 98 is included in Appendix A.

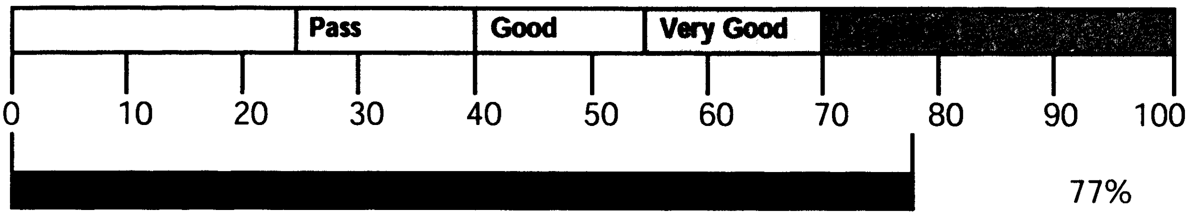
The building's rating is shown on page 5 and a summary of the credits obtained is provided on page 7. The building's rating is displayed on a certificate which can be displayed in the building or used for marketing purposes.

[1] *Background information and a summary of the BREEAM criteria is set out in the published BRE report BREEAM 98 for Offices which is available from CRC Publications Tel: 020 7505 6622.*

PERFORMANCE OF SCDC Office Building

BREEAM Rating

Based on the number of environmental credits achieved under each section and their relative importance



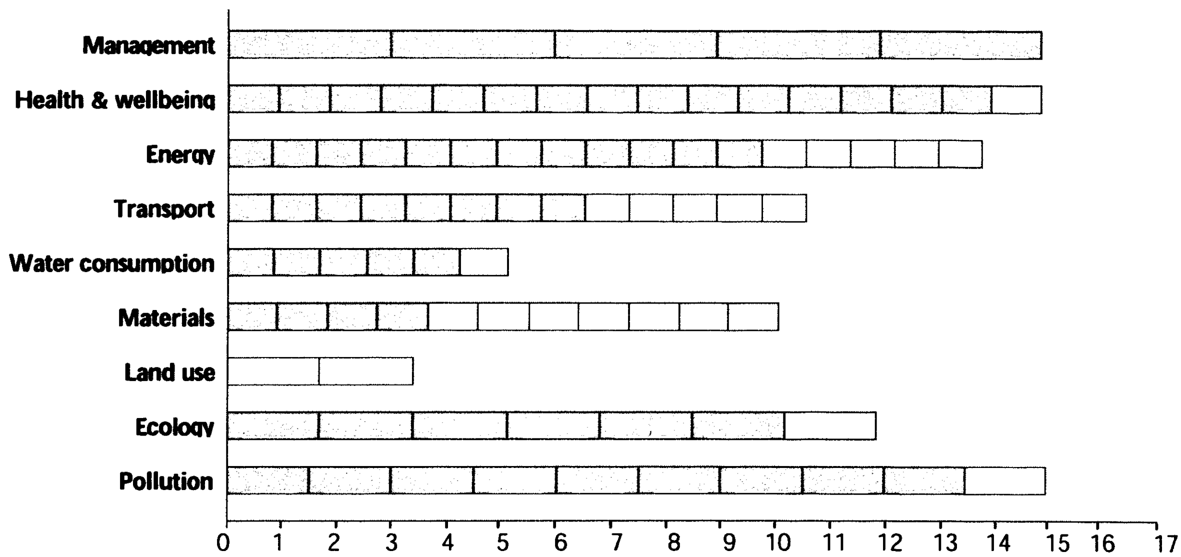
EXCELLENT

Environmental Performance Index

This scale provides a comparative measure of a building's performance between buildings assessed at different stages. It is based on the percentage of core credits achieved, multiplied by the Environmental Weighting Factor

EPI = 10

Performance by Category



An explanation of the rating system for BREEAM 98 is included in Appendix A.

OVERALL SUMMARY OF CREDITS

CATEGORY AND CREDITS		Core/ Design	Credits Available	Credits Achieved
Management	Adequate commissioning period	D	[redacted]	1
	Design team member monitoring commissioning	D	[redacted]	1
	Specialist commissioning agent appointed	D	[redacted]	1
	Contractual clause for contractor responsibility	D	[redacted]	1
	Re-commissioning guide for complex services	D	[redacted]	1
Health and well being	Legionnaires' disease 1 (airborne External)	C	[redacted]	1
	Legionnaires' disease 2 (domestic water services)	C	[redacted]	1
	Ventilation (10% external facade openable)	C	[redacted]	1
	Humidification	C	[redacted]	1
	Air quality (location of air intakes/outlets)	C	[redacted]	1
	Fresh air provision (Outside air to CIBSE/trickle vents)	C	[redacted]	1
	Daylighting	C	[redacted]	1
	Glare control (internal/external blinds fitted)	C	[redacted]	1
	Lighting (high frequency ballasts)	C	[redacted]	1
	Lighting levels (BCO specification)	C	[redacted]	1
	Lighting controls	C	[redacted]	1
	View to outside (with max. 7m to windows)	C	[redacted]	1
	Local temperature control	C	[redacted]	1
	Legionnaires' Disease 3 (cooling towers)	D	[redacted]	1
	Thermal comfort	D	[redacted]	1
	Indoor noise	D	[redacted]	0
Energy	Total net CO_2 emissions	C	[redacted]	10
	Sub-metering of energy use	C	[redacted]	1
	Check-metering (single tenant or multi tenant)	C	[redacted]	1
Transport	Transport CO_2 emissions	C	[redacted]	6
	Cyclist facilities (cycle storage, showers, changing)	C	[redacted]	1
	Access to public transport networks (commuting)	C	[redacted]	0
	Access to public transport networks (business travel)	C	[redacted]	1
Water consumption	Water consumption 4.5- < 5.5m³ per person/yr	C	[redacted]	1
	Water consumption 1.5- < 4.5m³ per person/yr	C	[redacted]	2
	Water consumption < 1.5m³ per person/yr	C	[redacted]	0
	Water Metering	C	[redacted]	1
	Water Leak detection	C	[redacted]	1
	Proximity detection water shut off in toilet areas	C	[redacted]	1
Materials	Asbestos	C	[redacted]	1
	Storage of Recyclable Materials	C	[redacted]	1
	At least 80% of upper floor slab achieve A rating	D	[redacted]	0
	At least 80% of external wall achieve A rating	D	[redacted]	0
	At least 80% of roof achieve A rating	D	[redacted]	0
	At least 80% of windows achieve A rating	D	[redacted]	0
	Solid Timber	D	[redacted]	1
	Composite timber panel products	D	[redacted]	1
	Reuse of more than 50% of existing facade	D	[redacted]	0
	Reuse of more than 80% of major structure	D	[redacted]	0
	Re-use of demolition materials.	D	[redacted]	0
Land use	Re-use of site	D	[redacted]	0
	Contaminated land	D	[redacted]	0
Ecology	Minimising ecological damage	D	[redacted]	1
	Ecological impact	D	[redacted]	3
	Ecological enhancement	D	[redacted]	1
	Protection of existing ecology	D	[redacted]	1
Pollution	Ozone depletion, refrigerants	C	[redacted]	1
	Ozone depletion, refrigerant leak detection	C	[redacted]	1
	Ozone depletion, refrigerant recovery	C	[redacted]	1
	Ozone depletion, halons	C	[redacted]	1
	Acid rain - NO_x emissions 200 or less mg/kWh	C	[redacted]	1
	Acid rain - NO_x emissions 99 or less kWh	C	[redacted]	1
	Acid rain - NO_x emissions 69 or less mg/kWh	C	[redacted]	1
	Acid rain - NO_x emissions 39 or less mg/kWh	C	[redacted]	1
	Protection of natural watercourses	C	[redacted]	0
	Ozone depletion, insulants	D	[redacted]	1

GENERAL BUILDING DETAILS

Orientation and form

The South Cambridgeshire District Council (SCDC) offices are a 3 storey building; ground, first and second floor, with office space on all three floors.

The building consists of 2 parallel wings, separated by an atrium, set out in a southeast – northwest orientation.

The building is based on a structural steel frame with 2 central cores, and 1 core at the southeast end. All cores are used for services, toilet areas and lifts.

Gross & Net floor area

The total gross floor area is 5,209m².

The total net lettable floor area is 4,200m².

Walls and frame

The walls of the building consist of aluminium framed curtain-walling, with brise soleil and stone rainscreen panelling. The average U-value of the opaque wall areas is 0.30 W/m²K.

The ground floor consists of insitu concrete on Rockwool insulation. The average ground floor U-value is 0.25 W/m²K.

Roof

Over the office wings, the roof consists of concrete paving slabs laid on mastic asphalt on insitu concrete.

The roof of the atria consists of an ETFE foil cushions in an aluminium frame (U-value, 0.25 W/m²K).

Glazing and shading

Glazing consists of high performance double glazed aluminium curtain walling. The average U-value of the glazed areas is 1.8 W/m²K.

Lighting

Lighting will consist of high frequency luminaires with Category 2 diffusers. Control will include daylight responsive dimming, and PIR absence detection.

Lighting is zoned to areas typically of 3m x 7m. Illuminance levels will be 400 lux in office areas. Lighting levels will be designed to 12W/m².

Heating Cooling and Ventilation

The building is designed for mixed mode operation.

Under natural ventilation conditions, ventiation is provided through the BMS controlled window vents, and stack ventilation through the central atrium.

Under displacement ventilation, fresh air is supplied by a roof located AHU.

Cooling is provided to the AHU by air cooled direct coupled condensers.

Heating is provided from 2 modular low NOx boilers, supplying trench radiators in the office area.

Hot water generation

Domestic Hot Water generation is provided by electric point of use heaters.

ASSESSMENT ISSUES

1. MANAGEMENT ISSUES

1.1 Commissioning Period

One credit will be awarded where evidence can be provided showing adequate time and budget allowances for commissioning are made on project programmes and in cost plans prior to occupation of the building.

Suitable evidence would include a programme of works indicating a clear period of no less than 2 weeks for commissioning.

AYH provided a proposed project programme, 'Programme A'. This programme demonstrates adequate commissioning, including 'Final commission services' scheduled for 6 weeks, commencing on 15th December 2003.

This credit has been achieved.

1.2 Design Team Responsibilities

One credit will be awarded where evidence can be provided that a design team member or members are expressly appointed to monitor commissioning on behalf of the client.

Suitable evidence would include

EITHER a letter of appointment of a design team member for responsibility for commissioning of services

OR specific reference to an individual(s) in the contract documents.

FaberMaunsell provided an extract of their preliminary specification 'A31 – Provision, Content and Use of Documents'. This document states that it is the responsibility of the Building Services Design Engineer to witness, monitor and comment on commissioning.

This credit has been achieved.

1.3 Commissioning Agent

One credit will be awarded where evidence can be provided that a specialist commissioning agent is appointed by either the client or contractor for complex systems including air conditioning, mechanical ventilation, displacement ventilation, passive ventilation systems, BMS, etc.

Where a building excludes any systems deemed to be complex this credit will be achieved by default.

Suitable evidence is defined as:

EITHER a letter of appointment of a commissioning manager

OR suitable reference to a commissioning manager within the contract documents.

FaberMaunsell provided an extract of their preliminary specification 'A30 – Schedule of Mechanical Manufacturers '. This document specifies that a Commissioning Specialist, who must be a member of the Commissioning Specialists Association, is appointed. The proposed project programme, 'Programme A', provided by AYH also specifics 'independent commissioning validation'.

This credit has been achieved.

1.4 Contractor Responsibilities

One credit will be awarded where evidence can be provided that ensures responsibilities for pre-commissioning, commissioning, quality monitoring are passed onto the appropriate contractors and all trades on site. In line with the recommendations as set out in BSRIA/CIBSE guidance.

Suitable evidence would include a copy of the relevant contract documentation which provides details of the contractors responsibilities.

FaberMaunsell provided extracts of their specification 'A31 – Provision, Content and Use of Documents' & 'Y51 – Testing and Commissioning of Mechanical Services'. These documents specify that sub-contractors are responsible for commissioning in compliance with CIBSE & BSRIA guidance.

This credit has been achieved.

1.5 Re-Commissioning Guide

One credit will be awarded where there is provision of a simple re-commissioning guide covering the key building services systems (heating, cooling, lighting, ventilation, humidification, etc.). This may be within a building manual or Health & Safety File.

Suitable evidence at the Design & Procurement stage would be a commitment to provide this together with a detailed outline of the contents would be sufficient to demonstrate this.

FaberMaunsell confirmed by email (24/10/02) that the specification requires a non-technical user manual suitable for re-commissioning, and this will included the following items:

- *Basic description of the servicing strategy in the building, including operation of ventilation, air conditioning and heating*
- *Energy efficient features of the building (such as free cooling) and control strategies to ensure that they operate as designed*
- *Water efficient features of the building (such as urinal controls, or dual flush WCs) and maintenance strategies to ensure they operate as designed*
- *BMS setpoints, including particularly time based setpoints, temperature setbacks, location of weather sensors where compensation is used, any automatically controlled ventilation systems (such as night cooling systems)*
- *Zoning of servicing and lighting, as installed drawings, master/slave groupings, etc.*
- *Office flexibility, including implications for partitioning on servicing (increased ventilation rates etc), suggestions for cellular areas (where speculative office, suggest the most appropriate areas for meeting space etc, such as proximity to risers, space for ductwork for additional ventilation)*
- *Other BREEAM issues, such as recycled materials storage, cycle spaces, showers etc*

More detailed re-commissioning information will be provided in the O&M manuals.

This credit has been achieved.

2. HEALTH & WELLBEING ISSUES

2.1 Legionnaires' Disease (Airborne External)

There is one credit where cooling tower locations are designed to allow ease of access to filters/drip trays etc. for cleaning/replacement, or no cooling towers. Cooling towers provide one of the major areas for microbial contamination and, therefore, present a substantial health concern.

BREEAM gives one credit for specifying one of the following:

- no air conditioning;
- air conditioning without wet cooling towers;
- air conditioning with wet cooling towers designed to the specification described in CIBSE TM13 and HSG70.

The design team confirmed at the design assessment meeting that there are no wet cooling towers associated with the building.

This credit has been achieved.

2.2 Legionnaires' Disease (Domestic Water Services)

The majority of outbreaks of legionnaires' disease are associated with the domestic hot water systems of non-domestic buildings. The Chartered Institute of Building Services Engineers (CIBSE), have recommended design procedures for minimising the risk of legionnaires' disease in their Technical Memorandum TM13. A credit is given for designs which comply with TM13.

FaberMaunsell have confirmed that the DHW system will be designed in accordance with CIBSE TM13 by completing the Health and Wellbeing Confirmation Form provided in the assessment meeting.

This credit has been achieved.

2.3 Ventilation

One credit will be awarded where at least 10% of external facades to office areas are openable and on at least two opposite sides. This should have an even distribution across the office area so as to promote adequate cross ventilation.

Drawings provided by Aukett (4245/EL/12100, 4245/RE/10202, 425/RE/10201) clearly demonstrate that more than 10% of the façade of the office area has openable windows, and extensive, even distribution will allow adequate cross ventilation.

This credit has been achieved.

2.4 Humidification

One credit will be awarded where steam humidification is installed OR where no humidification is present.

FaberMaunsell stated at the assessment meeting of 22/10/02 that a humidification system has not been specified for this building.

This credit has been achieved.

2.5 Air Quality

One credit will be awarded where location of air intakes/outlets serving occupied areas avoid major sources of external pollution.

Air conditioned and mixed-mode buildings:
Where location of air intakes/outlets

- are over 10m apart to minimise recirculation
- AND are over 20m from sources of major external pollution including other extracts, roads, vehicle manoeuvring areas, industrial extract etc.

FaberMaunsell provided a marked up copy of drawing 28828/M/501 'Roof Plant Scheme Layout', demonstrating a separation between the location of air intakes and outlets of 10.5m

This credit has been achieved.

2.6 Outside Air Provision

One credit will be awarded where either:

- Outside air is provided in accordance with CIBSE recommended ventilation rates in a/c mech. vent systems. This is currently 8 litres per person per second in instances where smoking is not permitted (16 litres per person per second - light smoking; 32 litres per person per second - heavy smoking)
- OR Trickle vents are provided on the majority of windows in naturally ventilated buildings

FaberMaunsell provided an extract of their preliminary specification 'A13sch – Schedule of Common Design Criteria'. This specifies a fresh air rate of 1.6l/s/m2person based on 10m²person.

The design team confirmed at the assessment meeting of 22/10/02 that the building will have a no smoking policy.

This credit has been achieved.

2.7 Daylighting

One credit will be awarded where at least 80% of net lettable office area is adequately daylit.

Credit is given if the following criteria are met in at least 80% of the office area:

- the average daylight factor exceeds 2%
- the sky must be visible from desk height from at least 80 % of each room
- the room depth criterion must satisfy: $d/w + d/h < 2/(1-R_B)$, where

  d = room depth
  w = width
  h = window head height
  R_B = average reflectance of surfaces in the back half of the room

FaberMaunsell provide a copy of the results of computer modelling conducted on the building, 'Cambourne Business Park, Computer Modelling - Offices And Atrium, Scheme Design Stage', demonstrating that an average daylight factor of at least 2% would be achieved.

Aukett provided a plan of the area surrounding the building clearly demonstrating that, with the surrounding area being largely undeveloped, at least 80% of occupants will be able to see the sky.

Drawings provided by Auckett (4245/RE/6000, 4245/RE/10100-10300, 4245/RE/10100-3) also demonstrate that the room depth criterion required for this credit will be meet.

This credit has been achieved.

2.8 Glare Control

One credit will be awarded where occupant controllable internal or external blinds are fitted to all windows to prevent glare.

Eddie Daines of Aukett provided written confirmation (email, 10/04/03) that 'there will be occupant controllable internal blinds on all office windows'.

This credit has been achieved.

2.9 Lighting, High Frequency Ballasts

One credit will be awarded where high frequency ballasts are installed in all general office luminaires.

FaberMaunsell confirmed at the assessment meeting of 22/10/02 that high-frequency lighting is to be installed in all office luminaires.

This credit has been achieved.

2.10 Lighting Levels

One credit will be awarded where lighting meets BCO Specification for Offices recommendations in terms of lighting levels. BCO specification for lighting states that the "Design for maintained illuminance level of 350-400 lux (open plan) with a uniform ratio of 0.8 over the defined task area in general offices areas". In addition light fittings should be designed and installed with Category 2 reflectors with design for inter-changeability with Category 1 and 3 louvres, without modification, being required.

FaberMaunsell provided a copy of the building specification, 'Cambourne Business Park, New Building 6010, Specification', Final Draft Rev V, 07.02.02. The specification states that lighting levels will be 400lux and in accordance with CIBSE LG3 guidance.

FaberMaunsell also provided written confirmation (email, 23/04/03) that light fittings would be Category 2, inter-changeable with Category 1 and 3 without modification if required.

This credit has been achieved.

2.11 Lighting Controls

One credit will be awarded where control of lighting in office areas relates to circulation space, daylighting and is zoned to provide separate control for groups of no more than 4 work areas.

FaberMaunsell provided drawings 28228/E/101 – 401, 'Lighting Layout'. These drawings demonstrate that lighting is zoned to typical areas of 3m x 7m (also confirmed by a separate email from FaberMaunsell sent on 01/11/02). The drawings also demonstrate that daylight sensors are specified to adjust lighting levels according to available daylight.

This credit has been achieved.

2.12 View to Outside

One credit will be awarded where all workstations to have view out with a maximum distance of 7m to the nearest window.

Aukett provided drawings (4245/RE/6000 to 4245/RE/6002, Space Plans) clearly demonstrating that no workstation will be more than 7m from a window.

This credit has been achieved.

2.13 Local Temperature Control

One credit will be awarded where local control is available for temperature in office areas to cope with different load requirements. This requires that the system is designed to allow for independent thermal control in all separate office areas including floors within the building and zoning should allow separate control of each perimeter area and the central zone.

FaberMaunsell provided an extract of their Mechanical Specification 'T31sch2 – Schedule of Trench Heating'. Stating that trench heating will be controlled in 6m sections by individual TRVs. This will allow individual temperature control of central and window areas, and individual areas along the perimeter.

This credit has been achieved.

2.14 Legionnaires' Disease (Airborne External)

One credit will be awarded where cooling towers/systems designed in accordance with HSG70 & TM13 or no cooling towers. If the building involves no air-conditioning or if the air conditioning system employs air cooled condensers, then credit is automatically given.

The design team confirmed at the design assessment meeting that there are no cooling towers associated with the building.

This credit has been achieved.

2.15 Thermal Comfort

There is one credit for minimising the risks of discomfort due to overheating of the building. The credit is awarded where it can be shown that assessments of thermal comfort levels have been made at an early design stage as well as at detailed design. The thermal assessment should be consistent with the CIBSE Guide, Volume A.

FaberMaunsell provide a copy of the results of computer modelling conducted on the building, 'Cambourne Business Park, Computer Modelling - Offices And Atrium, Scheme Design Stage', demonstrating that thermal modelling had been conducted in accordance with CIBSE guidance.

This credit has been achieved.

2.16 Indoor Noise

One credit will be awarded where design achieving ambient noise levels below:
- 40dB LAeqT in small offices
- 45dB LAeqT in large offices.

FaberMaunsell's Senior Acoustic Engineer stated (email, 28/10/03) that the BREEAM indoor criteria are likely to be achieved. However, no noise survey and noise intrusion calculations have been undertaken to confirm that the requirements will be met, so the credit cannot be awarded.

This credit has not been achieved.

3. ENERGY ISSUES

3.1 Carbon Dioxide Emissions

Credits will be awarded for predicted carbon dioxide emissions from the building, as follows:

CO_2 emissions	**Number of credits**
CO_2 emissions between 160 - 140 Kg/m²/yr	1
CO_2 emissions between 139 - 120 Kg/m²/yr	2
CO_2 emissions between 119 - 100 Kg/m²/yr	3
CO_2 emissions between 99 - 90 Kg/m²/yr	4
CO_2 emissions between 89 - 80 Kg/m²/yr	5
CO_2 emissions between 79 - 70 Kg/m²/yr	6
CO_2 emissions between 69 - 60 Kg/m²/yr	7
CO_2 emissions between 59 - 50 Kg/m²/yr	8
CO_2 emissions between 49 - 40 Kg/m²/yr	9
CO_2 emissions between 39 - 30 Kg/m²/yr	10
CO_2 emissions between 29 - 20 Kg/m²/yr	11
CO_2 emissions between 19 - 10 Kg/m²/yr	12
CO_2 emissions between 9 - 5 Kg/m²/yr	13
CO_2 emissions between 4 - 0 Kg/m²/yr	14
CO_2 emissions of 0 Kg/m²/yr	15

The annual energy consumption for this office has been predicted using the "ESICHECK" program. The following energy usage assumes standard occupancy patterns.

Gas	78.2 kWh/m²/year
Electricity	48.7 kWh/m²/year

This converts to the following CO_2 emissions:

Gas	*14.9 kg/m²/year*	*(use 0.19)*
Electricity	*22.9 kg/m²/year*	*(use 0.47)*
Total	*37.8 kg/m²/year*	

10 credits have been achieved.

3.2 Submetering of Energy Use

One credit will be awarded where sub metering is available for substantive energy uses within the building covering lighting and each of the following where present:

- Computer Room
- Catering Facilities
- Humidification Plant
- Cooling Plant
- Fans

FaberMaunsell provided a copy of the building specification, 'Cambourne Business Park, New Building 6010, Specification', Final Draft Rev V, 07.02.02. Section 19.3, Mechanical Services Design Criteria, states that 'meters shall be provided on main energy using plant throughout the building'. The design team confirmed at the assessment meeting of 22/10/02 that this would include the items required for this credit.

No computer room or humidification plant has been specified for the building.

This credit has been achieved.

3.3 Check Metering of Energy Use

One credit will be awarded where check-metering of electricity supply to tenancy areas (in multi-occupant buildings only) has been specified or where the building is occupied by a single tenant and is likely to remain so within the next five years.

FaberMaunsell provided 'LV Schematic Diagram' 28228/E/002, confirming sub-metering of each floor, with 4 discrete areas per floor.

This credit has been achieved.

4. TRANSPORT ISSUES

4.1 Transport

Ten credits are available depending on the predicted net CO_2 emissions arising from transport to and from the building. The number of credits is calculated using a spreadsheet-based calculation method which predicts the potential number of car journeys created by the office development and therefore the potential CO_2 emissions.

The calculation predicts the percentages of occupants travelling to and from the office in the following categories: bus, train, tube/metro, cycling, walking, individual cars and car sharing/pools.

CO_2 emissions	Number of Credits
CO_2 emissions less than 4500 kg/person/year	1
CO_2 emissions less than 4000 kg/person/year	2
CO_2 emissions less than 3500 kg/person/year	3
CO_2 emissions less than 3000 kg/person/year	4
CO_2 emissions less than 2500 kg/person/year	5
CO_2 emissions less than 2000 kg/person/year	6
CO_2 emissions less than 1700 kg/person/year	7
CO_2 emissions less than 1300 kg/person/year	8
CO_2 emissions less than 1000 kg/person/year	9
CO_2 emissions less than 750 kg/person/year	10

The proposed building is situated in on the edge of a small town in Cambridgeshire. Based on a net lettable area Of 4200m^2, a BRE defined occupancy density of 1 person per 10m^2 and the provision of 240 parking spaces the estimated CO_2 emissions are 1734 kg/ person/year. This figure falls within below the 2000 kg/person/year category and so 6 credits available are achieved.

6 credits have been achieved.

4.2 Cyclists Facilities

There is one credit for the provision of adequate cyclist's facilities.

The BREEAM credit is available for designing-in secure points to allow a minimum 10% of staff to lock bicycles adjacent to the building, sheltered from rain and snow. The design should allow one wheel and the frame to be secured together. In addition, at least two of the following features should be provided:

- changing facilities for cyclists;
- space for drying wet clothes;
- showers for cyclists.

Section 18.5 of the 'Cambourne Business Park, New Building 6010, Specification' provided by FaberMaunsell states that there will be 'Covered racked cycle storage to be provided for 100 cycles'. The location of the cycle storage is shown in drawing 28228ELE/M_E/008 'Site Services', provided by FaberMaunsell. This is more than double the amout of cycle spaces required by BREEAM.

Section 3.10 of the specification states the provision of a gymnasium within the building footprint that will provide the required facilities for showers, changing and locker storage. These facilities are shown in drawing 4245/RE/60000 'Ground Floor Space Plan, provided by Auckett'.

This credit has been achieved.

4.3 Access to Public Transport Networks (Commuting)

One credit will be awarded where good access to public transport networks within 500m and with a 15 min. service frequency to local urban centre.

No confirmation that the criteria for this credit could be met was provided.

This credit has not been achieved.

4.4 Access to Public Transport Networks (Business Travel)

One credit will be awarded where good access to public transport networks within 500m and with a 30 min. service frequency to major transport node.

Bus timetables were provided for Stagecoach bus services 130, Cambridge to Eaton Socon, and 14, Cambridge to Cambourne. Both buses stop at Cambourne Business Park, within 500m of the SCDC building. The two services combined provide services to a major transport node (Cambridge) at a frequency of every 30 minutes. The criteria for the credit are met.

This credit has been achieved.

5. WATER CONSUMPTION ISSUES

5.1 Water Consumption

Credits will be awarded for water conservation measures as follows:

	Number of credits
Predicted water consumption between 4.5 and 5.5m^3 per person per year.	1
Predicted water consumption between 1.5 and 4.5m^3 per person per year.	2
Predicted water consumption is less than 1.5m^3 per person per year.	3

FaberMaunsell have provided written confirmation (emails, 26/11/2002 & 23/04/2003) that Armitage Shanks Contour 6 litre flush WCs, Vola, mixer spray taps, and showers with a flow rate of 6-4.5 litres/s are specified for the development.

The BRE water consumption calculator predicts an annual water consumption rate of 4.48 m^3/person/year and awards this specification for this building 2 credits.

2 credit have been achieved.

5.2 Water Metering

One credit will be awarded where a water meter is installed to all supplies to the building.

The 'Mechanical Services Scope of Works - TENDER ISSUE - 31/10/02' and 'Cambourne Business Park, New Building 6010, Specification', section 18.3.1 specify the installation of a water meter covering all mains supply. This is to be located externally, under an accessible cover.

This credit has been achieved.

5.3 Water Leak Detection

One credit will be awarded where a leak detection system is installed covering all mains supplies. The leak detection credit is aimed at stopping damage and water wastage caused by leaks when the building is not occupied, e.g. at weekends, overnight, or when parts of the building are not let. The water leak detection systems would need to detect a significant change in water flow rates and shut off the mains supply automatically.

FaberMaunsell provided drawings (23603/CON008) and covering email (24/10/02) specifying a compliant automatic mains leak detection system, shutting off all incoming mains water.

This credit has been achieved.

5.4 Proximity Detection Water Shut Off

One credit will be awarded where a proximity detection shut off is provided to water supply in toilet areas. The proximity detector is required to shut off, taps W.C.'s and showers when no one is in the toilet block in order to meet the criteria for this credit.

FaberMaunsell provided drawings (23603/CON008) and covering email (24/10/02) specifying a compliant sanitary supply shut-off mechanism: 'Motorised MV shall open to toilet cores only when occupied as detected by the PIR,' covering water to all sanitary ware in the toilet areas.

This credit has been achieved.

6. MATERIALS ISSUES

6.1 Asbestos

One credit will be awarded where there is no asbestos in structure, services, lifts etc.

The design team confirmed at the design assessment meeting that no asbestos would be specified within the development.

This credit has been achieved.

6.2 Storage of Recyclable Materials

One credit will be awarded where presence of dedicated storage space for materials either within building or on site skips with good access for collections ($2m^2$ per $1000m^2$ up to $10m^2$ max.)

Aukett provided a drawing, 4245 (EL) 19110, specifying a compliant external ancillary building ('Ancillary Building 02') specifically labelled for the storage of recyclable waste. This measures $11.6m^2$ in area. This exceeds the $10m^2$ required by BREEAM for this building.

This credit has been achieved.

6.3 Materials Selection (Upper Floor Slab)

Credits will be awarded for major building elements that are evaluated against the specifications set out in the 'Green Guide to Materials Specification' as follows:

One credit will be awarded where at least 80% by area of upper floor slab specifications achieve an 'A' overall rating.

Drawings provided by Aukett confirm that upper floor slab construction is of precast reinforced slab with structural topping. This receives a B rating from the Green Guide.

This credit has not been achieved.

6.4 Materials Selection (External Wall)

One credit will be awarded where at least 80% by area of external wall specifications achieve an 'A' overall rating.

External wall construction was confirmed by Aukett as of aluminium framed curtain walling and stone rainscreen panelling. The aluminium curtain walling receives a B rating, and constitutes greater than 20% of the external wall.

This credit has not been achieved.

6.5 Materials Selection (Roof)

One credit will be awarded where at least 80% by area of roof specifications achieve an 'A' overall rating.

Information provided by Aukett demonstrates that more than 20% of the roof consists of insitu concrete with single ply membrane layer, insulation and ballast. This construction type receives a B rating.

This credit has not been achieved.

6.6 Materials Selection (Windows)

One credit will be awarded where at least 80% by area of window specifications achieve an 'A' overall rating.

Information provided by Aukett and FaberMaunsell demonstrates that the windows are constructed of aluminium composite curtain walling with timber internal frame. This achieves a B rating.

This credit has not been achieved.

6.7 Solid Timber

There is one credit available for avoiding the use of solid timber originating from unknown and unsustainable sources.

BREEAM gives one credit for specifying EITHER solid timber which is entirely from well managed, sustainable sources OR suitable re-used timber. Softwood timbers and temperate hardwoods are considered to be from sustainable sources. In the case of tropical hardwoods, the design team needs to provide the following information to demonstrate that the timber comes from a well managed, sustainable source:

- the species and country of origin;
- the name of the concession or plantation within the country of origin which supplied the timber;
- a copy of the forestry policy being pursued for the plantation or concession;
- shipping documents confirming that the timber supplier in the UK has indeed obtained their timber from the concession.

'Cambourne Business Park, New Building 6010, Specification', Section 4.0, supplied by FaberMaunsell, states 'All timber to be delivered to site to have an FSC mark'. The FSC standard will ensure that the above criteria is met for all timber specified for the building. Aukett also provided 'Specification for Scope of Works/Project Constraints for SCDC BUILDING 6010', which states in section 4100 Prohibited Materials that 'Wood, including plywood, taken from any non-sustainable source (including tropical rainforests)' is prohibited.

This credit has been achieved.

6.8 Composite Timber Products

There is one credit for specifying plywood which does not contain tropical hardwoods of unsustainable or unknown origin.

The credit is available for specifying EITHER timber panel products which are entirely from well managed, sustainable sources OR suitable re-used timber. The following clause gives clear guidance to a contractor concerning the supply of plywood:

" • Plywood of unknown composition is expressly prohibited.
- Plywood comprised of solid temperate hardwoods (or softwoods) may be used, such as solid Birch, or solid Douglas Fir plywood.
- Plywood containing tropical hardwood is prohibited, unless certification is provided. The certification should include the following:
  - the species and country of origin;
  - the name of the concession or plantation within the country of origin which supplied the timber;
  - a copy of the forestry policy being pursued for the plantation or concession.
  - shipping documents confirming that the timber supplier in the UK has indeed obtained their timber from that concession.

The contractor is to confirm in writing to The Project Manager the species of timber contained in the plywood, and how they have met the above specification.

The contractor's attention is drawn to the fact that plywood may contain timber from unknown or unsustainable sources."

Including such a clause in the specification for plywood would meet the criteria for this BREEAM credit.

'Cambourne Business Park, New Building 6010, Specification', Section 4.0, supplied by FaberMaunsell, states 'All timber to be delivered to site to have an FSC mark'. The specification includes the supply of composite timber, including plywood, and the FSC standard will ensure that the above criteria is met.

Aukett also provided 'Specification for Scope of Works/Project Constraints for SCDC BUILDING 6010', which states in section 4100 Prohibited Materials that 'Wood, including plywood, taken from any non-sustainable source (including tropical rainforests)' is prohibited.

This credit has been achieved.

6.9 Building Materials Containing Waste or Re-Used Materials (50% of Facade)

One credit will be awarded where reuse of more than 50% of existing façades by area.

The development is entirely new build and no recycled materials have been specified for the external facade.

This credit has not been achieved.

6.10 Building Materials Containing Waste or Re-Used Materials (80% of Structure)

One credit will be awarded where reuse of more than 80% of major structure by building volume.

The development is entirely new build and no recycled materials have been specified for the external facade.

This credit has not been achieved.

6.11 Re-Use of Demolition Materials

There is one credit for re-using demolition material.

BREEAM gives one credit for using one or more of the following:

- suitable uncontaminated demolition materials, wherever appropriate, in fill and hardcore and/or granular road base;
- crushed concrete aggregate complying with the quality and grading requirements of British Standard BS882 for use in concrete for foundations, over-site slabs, hardstanding, paths or site roads.

The design team confirmed at the design assessment meeting that demolition materials had not been specified for the development.

This credit has not been achieved.

7. LAND USE

7.1 Re-Use of Site

One credit will be awarded where the site has been previously built on or used for industrial purposes within the last 50 years.

The design team confirmed at the design assessment meeting of 22/10/02 that the site has not been built upon in recent times. Its previous use was as arable field.

This credit has not been achieved.

7.2 Contaminated Land

One credit will be awarded where land is defined as contaminated and where adequate steps have been taken to contain or clean the site prior to construction. Evidence of survey and consultants report will demonstrate targets to be achieved. The aim of this credit is to encourage the re-use and cleaning up of contaminated land, therefore, if the land is not contaminated, the credit will not be achieved.

The design team confirmed at the design assessment meeting of 22/10/02 that the site is not contaminated.

This credit has not been achieved.

8. ECOLOGY

8.1 Minimising Ecological Damage

One credit will be awarded where land is defined as of low ecological value.

An assessment has been undertaken by Catherine Bickmore Associates, who BRE recognise as Ecological Consultants. The assessment, 'Cambourne Business Park; South Cambs District Council, Ecological survey and BREEAM assessment,' recommends that this credit is awarded.

This credit has been achieved.

8.2 Ecological Impact

Credits will be awarded for the level of ecological impact that the development has on the site, as follows. The change in ecological value is established by estimating the number of species of wildlife on the site before and after the development.

Ecological Impact	Number of Credits
Where change in ecological value of site is minor and negative.	1
Where change in ecological value of site is neutral.	2
Where change in ecological value of site is minor and positive.	3
Where change in ecological value of site is significant and positive.	4

An assessment by Catherine Bickmore Associates, BRE recognised Ecological Consultants, states a change in ecological value of + 5 spp/ha and recommends 3 credits are awarded.

3 credits have been achieved.

8.3 Ecological Enhancement

One credit will be awarded where seeking and acting on advice from one of the following organisations on the best ways to enhance the ecological value of the site:

- Association of Wildlife Trusts Consultancies (AWTC)
- A registered Environmental Impact Assessor member of the Institute of Environmental Management and Assessment (IEMA)
- A registered member of the Institute of Ecology and Environmental Assessment (IEEM)

An assessment by Catherine Bickmore Associates, BRE recognised Ecological Consultants, details advice given to the client that they have committed to undertake, and recommends that this credit is awarded.

This credit has been achieved.

8.4 Protection of Existing Ecology

One credit will be awarded where contract specification ensures that all trees over 100mm trunk diameter. Hedges, ponds, streams etc. are maintained and adequately protected from damage during construction works.

An assessment by Catherine Bickmore Associates, BRE recognised Ecological Consultants, recommends that this credit is awarded.

This credit has been achieved.

9. POLLUTION

9.1 Ozone Depletion, Refrigerants

One credit will be awarded where the refrigerant type has an ODP of ZERO or where there are no refrigerants present.

FaberMaunsell provided an extract of their specification 'T60 – Central Refrigeration Plant' stating 'Refrigerants to have an Ozone Depletion Potential (ODP) of Zero'.

This credit has been achieved.

9.2 Ozone Depletion, Refrigerant Leak Detection

One credit will be awarded where presence of refrigerant leak detection systems covering high risk parts of plant (condenser coil can be omitted from this) or no refrigerants. A UV or 'sniffer'-type system is suitable.

FaberMaunsell provided manufacturers confirmation (faxed letter from Airedale International Air Conditioning Ltd, 7th January 2003) stating that 'refrigeration leak detection is via a 'sniffer' unit... connects to the BMS... is fully automatic and factory fitted and tested prior to despatch'.

This credit has been achieved.

9.3 Ozone Depletion, Refrigerant Recovery

One credit will be awarded where provision of automatic refrigerant pump down to coil or storage tanks with isolation valves or no refrigerants.

FaberMaunsell provided manufacturers confirmation (Faxed letter from Airedale International Air Conditioning Ltd, 7th January 2003) stating that 'Pump down facility is to the condenser coils and will be automatic on detection of a leak... fitted with liquid and discharge ball valves.'

This credit has been achieved.

9.4 Ozone Depletion, Halons

One credit will be awarded where absence of Halon based fire-fighting systems.

Phil Craig of FaberMaunsell provided written confirmation (fax, 07/04/03) that no Halons have been specified for the buildings fire-fighting system, in line with current building regulations.

This credit has been achieved.

9.5 Acid Rain, NO_x Emissions

Credit is given for specifying boilers which are fitted with reduced-NO_x emitting burners and which have maximum NO_x emission levels, as follows:

Emissions	**Number of Credits**
for emissions between 100 and 200 mg/kWh delivered heating energy.	1
for emissions between 70 and 99 mg/kWh delivered heating energy.	2
for emissions between 40 and 69 mg/kWh delivered heating energy.	3
for emissions less than 40 mg/kWh delivered heating energy.	4

FaberMaunsell provided written confirmation that gas condensing boilers manufactured by Hoval have been specified for this building. Manufacturer's information for the boilers has been provided, confirming that the average NOx emissions are 20mg/kWh.

4 credits have been achieved.

9.6 Protection of Natural and Municipal Watercourses

One credit will be awarded where site facilities reduce potential for run off to natural watercourses and/or municipal watercourses by 50% and where on site treatment such as oil interceptors / filtration is present.)

The aim of this credit is to reduce the flash runoff levels caused by storm water and so reduce pressures on the municipal or natural systems that traditionally deal with it. Excessive water runoff can harm habitats of local water courses and cause erosion. Water runoff can also wash pollutants on the ground (such as oil from cars) into local water courses. Surface water runoff from building roofs can be stored in on-site holding facilities (tanks, soakaways etc.) or it can be stored and reused as grey water.

No confirmation has been provided to confirm that peak site run-off will be attenuated by 50%.

This credit has not been achieved.

9.7 Ozone Depletion, Insulants

One credit is given in BREEAM for the use of insulation materials which use neither CFCs nor HCFC in their manufacture.

There is one credit for specifying thermal insulants in building fabric and services made only from materials with zero Ozone Depletion Potential. A full description of all the insulation materials specified will be checked for the presence of ozone-depleting agents. If there is any doubt about the ozone depletion potential of the material, the design team must provide details from the manufacturer. The credit will only be achieved if it is shown that **none** of the insulation materials specified in the building **contain CFCs or HCFCs**.

Faber Maunsell provided an extract of their Mechanical and Electrical specification, stating that all insulants are 'made using materials with zero ODP potential'. FM 'Y50sch – Schedule of Thermal Insulation' specifics 'CFC and HCFC free' insulation for all services insulation.

Aukett also provided 'Specification for Scope of Works/Project Constraints for SCDC BUILDING 6010', which states in section 4100 Prohibited Materials that 'Insulation and similar products containing and/or utilising in production either HCFC and/or CFCs' is prohibited.

This credit has been achieved.

APPENDIX A

Explanation of the BREEAM 98 rating system

THE RATING SYSTEM FOR BREEAM 98

Buildings are awarded two ratings under BREEAM. The rating depends on how many environmental credits are achieved under each section and their relative environmental importance. The two ratings that are awarded are:

1. An overall BREEAM rating of Pass, Good, Very Good or Excellent, depending on the overall number of credits achieved.
2. An Environmental Performance Index on a scale of 1 to 10. This is derived from the number of Core credits achieved. Core credits are those issues that can either be implemented at the design stage or after the building has been built e.g. installation of water meters.

The overall rating is derived from the percentage of credits achieved under each heading, multiplied by the Environmental Weighting Factor:

CATEGORY	Number of credits available	Weighting factor
Management	5	15
Health and wellbeing	16	15
Energy Transport	17 13	25
Water consumption	6	5
Materials	11	10
Land use Ecology	2 7	15
Pollution	10	15

The total of all these scores is the overall rating and a rating is awarded according to the following scale:

Pass	Good	Very Good	Excellent
25 – 40	40 – 55	55 – 70	70 – 100

The Environmental Performance Index is based on the percentage of core credits achieved, multiplied by the Environmental Weighting Factor. The final score is derived from the following scale:

Percentage of core credits achieved

30 40 50 60 70 80 90 100

1	2	3	4	5	6	7	8	9	10

Environmental Performance Index

Appendix C: Surveys

Appendix C: Surveys

Surveys

South Cambs District Council: visit 4th March 2008

A look around with Caretaker Stuart and leave Hobo's to monitor Temp and Relative Humidity

Information gathered:

1. Top floors hotter than ground floor
2. Displacement ventilation used with circular air inputs, not swirl ventilators.
3. Steel frame construction with intumescent paint protection. Precast concrete floor planks.
4. Very hot first summer.
5. Louvre protection to the South-west elevation altered to allow view out too claustrophobic in office when closed.
6. Blinds added in entrance due to solar gain the entrance faces due south.
7. EPDM roof over the atrium was extremely noisy during rainfall. The membrane acts as a drum and the hard surfaces in the atrium as an amplifier. Impossible to use the phone due to the noise during rainfall. The problem was allowed for and a mess installed over the roof to take the kinetic energy out of the rainfall. The mesh flaps from the high winds across the building.
8. Access to roof via escape stairs is poor for servicing and vertigo inducing for the unwary.
9. New internal rooms not obvious how they are ventilated with no windows only air input from vents.
10. The air inputs are too close to staff at desks causing draughts.
11. Temperature sensors in central toilet area at 1500mm high.
12. Atrium does not extend full length of the floor plate. The offices must be conventionally vented with windows either-side.

13. Servicing of lights in atrium not considered thoughtfully a cherry-picker is needed for access. As the floor tiles are laid on dabs they need to be overboarded with plywood to prevent them being broken by the point loading.

14. Roof is an inverted flat roof with paving slabs as ballast. Some initial problems with leaking.

15. The BMS system runs the whole building by a remotely controlled computer system. The whole system needs resetting after a power cut by the remote controller. Big brother!!

16. Chiller on roof very noisy or is it extract needs to be clarified?

17. Chiller in hot weather cuts in when a threshold temperature is reached in the building. The occupants to gain a cooling breeze open windows which delays the temperature rise for the chillers to cool the building. Caretaker staff has to go around the building asking the staff to shut windows to cause the temperature to rise so the chillers work. Question is; is the threshold temp for the chillers to cut in too high for the occupants.

18. Orientation of the building is strange why not East-west. Consequently solar gain occurs in the entrance. The site plan seems to determine the orientation of the building to retain the orthogonal layout of the office pavilions.

19. Horizontal louvres in the entrance look good but how effective?

20. The building has a basic planning problem the Council Chamber is accessible from the public entrance but not the meeting rooms. So visitors have to go through security to gain access.

21. Cambourne is an unattractive sterile new town with no sense of intimacy or detail. So the staff in the council offices are unlikely to relocate locally necessitating travel and **excess carbon emissions. Cambourne may be summed up by the fact that Morrison's** supermarket is the focal centre of the town.

22. Staff travel from as far afield as Ely, Royston and Cambridge. Whilst initially a bus service from Cambridge was provided that has now ceased so unsurprisingly the car park is proving inadequate for the offices.

23. The move to relocate in Cambourne was prompted by the desire to be in the centre of the locality the office serves. Previously the office had been in Cambridge city.

South Cambs District Council: visit 13th June 2008

A look around with Caretaker Stuart and leave Hobo's to monitor Temp and Relative Humidity

Information gathered:

1. At night the windows open to night cool the building due to the high wind speeds across the flat Cambridge corn fields papers had been blown across the office setting the alarms off. The response was to restrict the window opening reducing the night cooling.

2. Printers in the office had originally been distributed evenly throughout the office the heat loads must have been calculated by Fabers on that basis. As an economy measure the printers have been centralised around the toilet core close to the office. This will affect the local air raising the temperature in turn deceiving the sensors which run the whole building. A change taken without due thought!

3. The building temperature not uniform along its length tends to be cooler to the entrance end this may be due to the repositioning of the sensors with the local heat load.

4. Need to measure the air temperature difference between the air input from the vents to the air temperature. It may be too large for thermal comfort as specified with displacement ventilation.

5. Need to find out if they are night-time cooling. If not it may be beyond the capacity of the AC system to cool the building.

6. Input vents too close to desks for thermal comfort maximum 1metre distance.

7. Occupants put bins over air inputs to reduce cooling draughts.

8. Reception needs own air input should not rely on second hand air from flanking offices. Staff develop headaches from stuffy air and ask for entrance doors to be opened. This may suggest high Carbon dioxide levels.

9. Tree planting around car-parking is to be thinned to allow stronger trees to flourish.

10. For Breeam submission was it stated that a bus service would be available from Cambridge. Agreed with unions to have bus service for four years. Now ceased and all staff drive hence car-parking shortage. Only a bus in evening and morning not adequate for staff in building vastly increasing the CO2 emmisions of the office.

11. Not building on adjoining site due to discovery of great crested newt.

12. Overheating occurs on shade or car-park side of the building in the evening. No shading allowed for in the design.

13. The original Facilities Manager, who was highly regarded throughout the office took early retirement. The office caretaker implied it was due to the stress of running the office.

Appendix D: Meetings

Meetings

To gain a thorough understanding of the building and the build process a series of semi-structured interviews were conducted with the professional parties concerned with designing and managing the building. A full draft of each meeting is in AppendixCCC for brevity only the more salient issues are noted.

Anna Lumsden: Associate Aukett Architects

Meeting in Bristol 14th September 2007

1. Anna first outlined the structure of the project team
2. Design and build Contract with Auketts novated as detail design architects
3. The building has been published in:
   Ecotech Sustainable architecture
   BCO awards brochure
   Sustainable Development RIBA publication
4. Anna as associate closely involved with the build
5. The building was built very quickly this caused problems with quality
6. Steelwork arrived on site before drawings for steelwork approved by architect
7. Design pared to the bone
8. The plantroom on the one side of the roof conflicted with the natural ventilation extract
9. Faber Maunsell commissioned BMS over the first two years of the building operation

Brent O'Halloran: South Cambridgeshire District Council

Meeting at SCDC 10th June 2008

1. It is discernibly colder on the North-west side of the building than the South-east.
2. At present the roof vents are not operating the council is in discussion with the software operator about who is responsible for the cost of rectifying the problem. No clear division of responsibilities!!
3. The air in the building becomes stuffy later in the day.
4. Draughts from floor vents in offices frequent complaints.
5. Complaints about cold in the morning suggest that the slab is being overcooled.
6. Hotter at the top of the building later in the day.
7. Reception complaints about stuffy air mitigated by opening the front door which reduces the effect of the stack effect by the atrium.

8. Heaters under desks to overcome coolth from night-time cooling.
9. Fans also used for cooling
10. These problems suggest occupants need or desire personal control.
11. Facilities to change the system have to ring the remote controllers of the BMS system very slow response and very frustrating.
12. Acknowledged that need a full-time facilities manager to run the building. The recent appointment of a part-time manager had caused problems that he was unable to address due to other work commitments. The original Manager had retrospectively been the correct appointment as he had, in an unappreciated way, run the building smoothly solving problems as soon as they had occurred.

Peter Eaton: Director Aukett Architects

Meeting at Aukett Fitzroy Robinsons Regent Street Office 12th June 2008

1. Peter organised contact names and numbers with Faber Maunsell the services engineer
2. Faber did Breeam submission
3. Scheme based on Open Government Agenda 21
4. The louvres on scheme reacted too quickly, irritating people, and closed completely for the sun occupants felt too enclosed. Decided to fix them semi-closed which would achieve 90% shading without the constant movement of the louvres.
5. Velfac cladding was used on the external walls and their recommended installers proved problematic.
6. Controls and wiring separate 4 different contracts impossible to manage.
7. McAlpine struggled with the organisation of the contract
8. Fabers had a legal agreement with the developer to meet prescribed energy consumption!

Adam Mathews: Architect SCDC designer

Meeting in North Greenwich at Office of Adam Mathews 26th June 2008

1. SCDC was a limited competition Aukett had master-planned the Cambourne Office Park site.
2. Auketts was a multidisciplinary practice which aided the low energy design process

3. Justified scheme on commercial premise that the client would get more rental space and a better working environment for less cost. The developer would not be particularly interested in running costs which would be concern of the occupier.
4. The client had been more open to the risk of a mixed mode building because already had South Cambridgeshire as a client which took out a lot of the risk. The task was to convince South Cambs this was done by highlighting the forthcoming Legislation for Sustainability and Energy use from European Directives. The prime example being the just introduced Energy Certificate for Public Buildings. Also the lifecycle costing of the building was emphasised to justify slightly higher expenditure. The Developer Development Securites could see that advantage of the sustainability as an added attraction for marketing the building. Letting the building at a higher price because the running cost would be lower. Radical thinking!!
5. SCDC was also developed so it could later in life be let as a speculative office let should the Council move. The building was also designed as an extrusion so it could be extended. The escape stairs being dismantled and re-erected at the end of the new extension.
6. Inspiration for the design came from several disparate sources. The Ionica Headquarters Cambridge with its passive atria ventilation system and the separation of the high heat load spaces so they could use AC. Gateway 2 by Arups which uses the **stack effect of the atria to draw air though the adjoining offices. Edward Cullinan's** Centre for Mathematical Studies Cambridge and Bennett Architects Powergen are similar atria buildings.
7. Mathew though building control for the occupants should be simple and understandable. People have become used to AC and do not know when or when not to open a window. For example opening a window on a hot day when it will simply let in hotter air.
8. The higher up the building the less the windows would be allowed to open to keep the draw of the stack effect. Occupants resorted to dismantling the window stays to open the windows wider. Again ignorance the occupants need to be educated on how to use the building.
9. The control systems for windows that automatically after went back to a default position **after being opened were 'value engineered' out.**
10. A major reason for commissioning a new building was the high turnover of staff in Cambridge because the small dingy offices. Wanted the appeal of a light open plan airy building. Since moving to Cambourne with the new offices staff turnover has reduced.
11. It appears the louvres had been a contentious issue throughout the design.
12. A low E glass had been used as a cost saving with the building in turn for the louvre provision for the building.

13. The design was conceived with rule of thumb garnered from BRS publications particularly the Environmental design Guide.
14. Latterly in the design Fabers became concerned about the opening windows free area in the lantern which was not adequate in the sub-contractors drawings.
15. The plantroom was located to oneside of the atria. Mathew confessed that to keep the integrity of the EPDF roof Auketts had inssited that the services had been routed from one side of the atria to the other under the street at considerable extra expense and loss of efficiency of the ductwork. The roof does look good though!
16. The Plantroom grew despite the efforts of the architect in part due to the fact it was a design and build contract. The plantroom started to impinge on opening windows in the top of the lantern. Ironically in the finished building the plantroom is very generous because the actual services contractor rather than the design contractor did not need the space.
17. The wind rose for the site had no effect on the design the street lantern is designed solely to work with the stack effect.
18. Adam to advertise wanted a large display in reception showing the Energy consumption of the building unfortunately one of the cost cuts by the developer.
19. Discussing the problems at South Cambs with the BMS system Adam noted that the Wessex Water building by Bennetts Associates the first year energy use was far higher than the predictions. Revisiting the building is a policy of Bennetts. They corrected the problems in the use of the building by educating the occupants and the energy use dropped to the original expectations. This shows the importance of feedback with design.
20. The temperature levels set by Fabers came from the CIBSE AC standards rather than the BRE standard which was looser. With the temperature problems in the building the question must be asked are AC temperature criteria suitable for a mixed mode building.
21. ETFE was used over the lantern for the simple reason that it was cheaper than glass.
22. The automatic air input is at a high level Adam was not sure whether it was correct decision he thought in retrospect that the automatic air input should have been at a low level which would have aided air movement across the office slab.
23. Where the cellular offices are located a sound insulated panel was used between the slab and the partition wall to allow air movement to the atria. Adam thought this had worked well.
24. Adam had hoped that over time the use of the AC would fade away and the building would have simply become naturally ventilated. Although the building was designed so later in life it could be fully Air Conditioned.

Phil Craig: Regional Director Faber Maunsell

Meeting in St Albans at Faber Maunsells Office 30th June 2008

1. Phil first explained the mixed mode ventilation system
2. Agreed to supply a copy of the Breeam assessment
3. Initially the BMS did not work correctly. The sophisticated window system by Window Master an associate firm of Velfac the window and curtain walling manufacturer for the project had its own control system which did not communicate with the BMS system. It took 6 months to sort the teething problems out.
4. Providing fresh air for the corners of the building proved problematic.
5. Had a related problem with the corners of the building warming up too much in summer
6. In high winds, prevalent in Cambridgeshire the window openings are designed to adjust.
7. The window control system used purge ventilation in the morning.
8. The modelling done by Faber Maunsell had to be verified by Hoare Lea Bristol due to concerns from the Council.
9. Fabers had modelled the building in IES the in-house programme.
10. The building section was modelled in a CFD programme to check the capacity of the Lantern over the atrium street to retain heat needed for the stack effect to draw the air out in summer.
11. Phil Craig was aware of the problem of the print machines and photocopiers being located next to the sensors around the toilet block areas it had happened at a late date in the fitting out and no budget existed to move the sensors. The professional decision had been that it would not distort the readings to the BMS unduly as modern copiers have a low heat output.
12. Phil Craig then supplied key documents including an article written for the inhouse Faber Maunsell magazine on SCDC.

Graham Middleton: New Facilities Manager South Cambs

Meeting at South Cambridgeshire District Council 13th August 2008

1. Graham provided South Cambs energy figures which are due to be posted on the Energy Certificate for a public building in October.
2. Discussing the problems with the building Graham noted that the sensors running the BMS system are located in the chiller enclosure. Due to the heat output of the chillers this has a separate microclimate to the outside so the BMS is receiving distorted external readings.

3. The building switches off at the weekend.
4. Graham described the internal environment as one of extremes either too hot or too cold.

Appendix E: Energy Use

Energy Consumption

Method used from Econ 19 published by the CIBSE

Net/Gross Area

	GIA M	GIA Ft	NIA M	NIA Ft
Ground	2,036	21,915	1,861	20,032
First	1835	20,430	1,682	18,105
Second	1,746	18,794	1,611	17,341
Roof Plant room	219	2,357		
Total	**5,899**	**63,496**	**5,154**	**55,477**

South Cambridgeshire Area's

Month 2007-08	Gas Energy Consumption KWh
February	59627
March	44450
April	15814
May	31323
June	10263
July	5875
August	7425
September	12903
October	27586
November	38902
December	88920
January	100179
Total	443267

Month 2007-08	Electric Energy Consumption KWh
March	64588
April	63358
May	66490
June	66775
July	69003
August	66000
September	64858
October	64591
November	61509
December	63135
January	63599
February	61509
Total	775415

South Cambridgeshire Energy Figures

From defra website conversion figures from KWh to $KgCO_2$

Natural Gas 0.20 $KgCO_2$ per KWh

Electricity 0.54 $KgCO_2$ per KWh note this is a general figure for the electric grid.

For a mixed mode building the Carbon Trust assume benchmarks between office type 2 naturally ventilated and office type 3 air-conditioned.

	1		2		3		4	
	Good practice	Typical	Good practice	Typical	Good practice	Typical	Good practice	Typical
Total gas or oil	79	151	79	151	97	178	114	210
Total electricity	33	54	54	85	128	226	234	358

Table B1 Annual delivered energy consumption (EUI) of good practice and typical offices for the four office types (kWh/m² treated floor area)

	1 Good practice	1 Typical	2 Good practice	2 Typical	3 Good practice	3 Typical	4 Good practice	4 Typical
Total gas or oil	15.0	28.7	15.0	28.7	18.4	33.8	21.7	39.9
Total electricity	17.2	28.1	28.1	44.2	66.6	117.5	121.7	186.2
Total CO_2 emissions (expressed as $kgCO_2/m^2$ of TFA)	32.2	56.8	43.1	72.9	85.0	151.3	143.4	226.1

Table B3 Annual emissions of CO_2 (CEI) ($kgCO_2/m^2$ of treated floor area) using CO_2 emission factors of 0.19 $kgCO_2/kWh$ for gas and 0.52 $kgCO_2/kWh$ for electricity

For a mixed mode building the benchmarks for KWh/m² are:

Good Practice:

Gas 87 KWh/m²

Electricity 91 KWh/m²

Typical:

Gas 165 KWh/m²

Electricity 155 KWh/m²

For a mixed mode building the benchmarks for $KgCO_2/m^2$ are:

Good Practice:

Gas 16.7 $KgCO_2/m^2$

Electricity 47.35 $KgCO_2/m^2$

Typical:

Gas 31.25 $KgCO_2/m^2$

Electricity 80.85 $KgCO_2/m^2$

South Cambs KWh

Gas 443,267 KWh Area 5,154m²

443,267 / 5154 = 86 KWh/m²

Electric 775,415 KWh Area 5,154m²

775,415 / 5154 = 150 KWh/m²

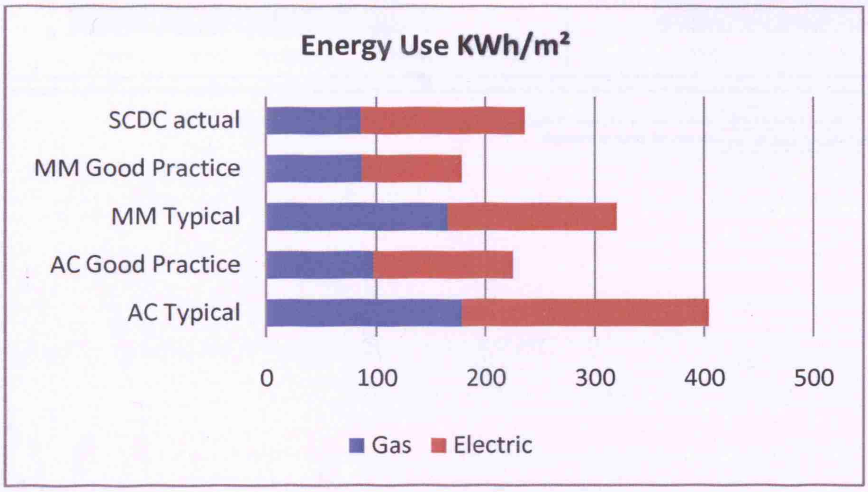
South Cambs CO_2

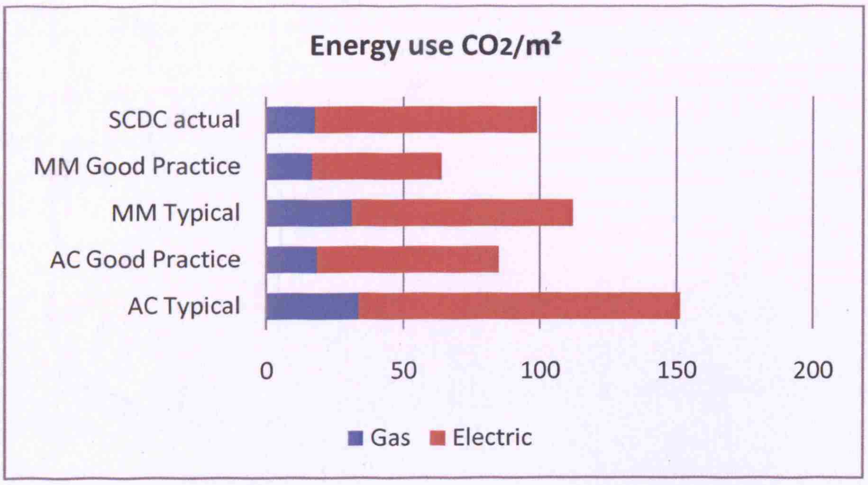
Gas 443,267 KWh x 0.206 = 91,313 $KgCO_2$

Electric 775,415 KWh x 0.54 = 418,724 $KgCO_2$

Gas 91,313 / 5,154 = 17.72 $KgCO_2/m^2$

Electric 418,724 / 5,154 = 81.24 $KgCO_2/m^2$





RESULTS OF OVERALL ASSESSMENT

Building name	South Cambridgeshire Hall		
Date and reference	1/8/2008		
Overall grade	D	QA:	Overall QA status: Approved
Building floor area m2	6,782	QA:	Approved
Annual energy use electricity (kW	775,415	QA:	Approved
Annual energy use non-elec (kWh)	443,267	QA:	Approved

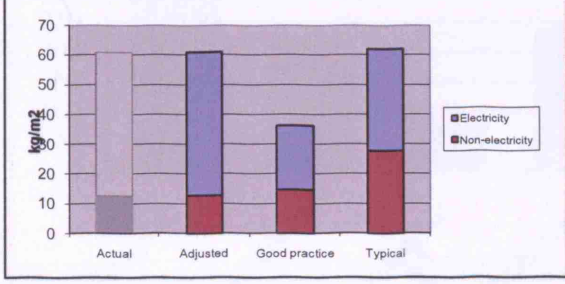
Annual energy performance compared with benchmarks

	Metered energy		Benchmarks		Grade		
	Actual	Adjusted	Good practice	Typical			
Electricity kWh/m2	114	114	52	81	E	122% worse than Good Practice	41% worse than Typical
Non-electricity kWh/m2	65	65	75	144	B	13% better than Good Practice	54% better than Typical
Carbon emissions kgCO2/m2	61	61	36	62	D	68% worse than Good Practice	2% better than Typical
Cost £/m2	£9.07	**£9.07**	**£5.23**	**£8.85**	E	**74% worse than Good Practice**	**2% worse than Typical**
Building total kg CO2	413,200	413,200	246,200	420,300	D	167,000 worse than Good Practice	7,100 better than Typical
Building total cost (£)	£61,500	**£61,500**	**£35,400**	**£60,000**	E	**£26,100 worse than Good Practice**	**£1,500 worse than Typical**

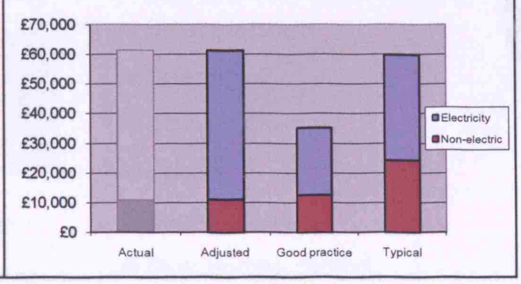
Additional Carbon grading with the benefit of any green energy supplies - for information only:

Carbon emissions kgCO2/m2	61	61	36	62	D	68% worse than Good Practice	2% better than Typical

Annual emissions measured as kg Carbon Dioxide per m2



Total annual cost - comparison with benchmarks for this building

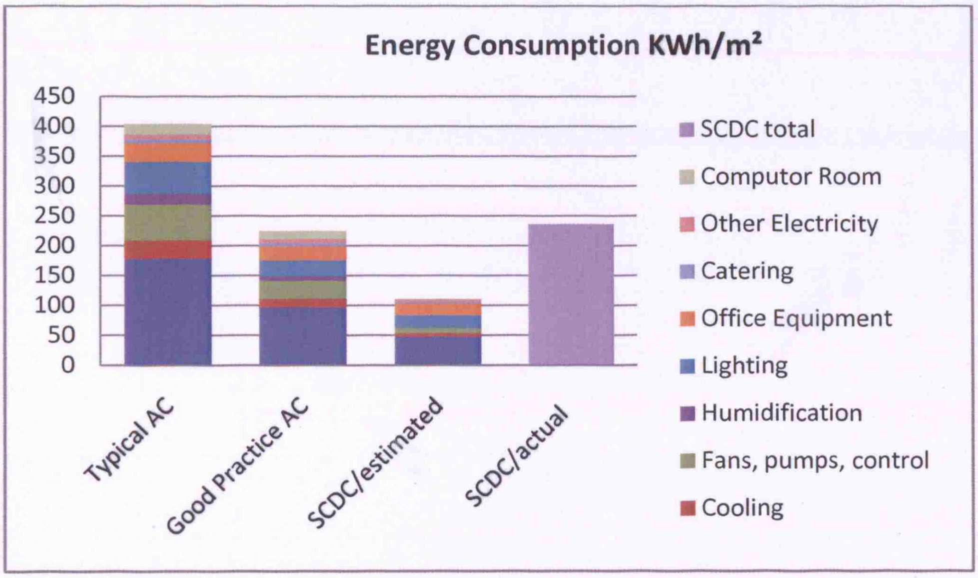


Select Carbon basis for above results: CO2 emissions as kgCO2

Select size basis for results: per m2 Gross Internal floor area

Breakdown of Energy Consumption

The Breakdown of Energy Consumption is derived from calculations prepared by Faber Maunsell for the submission for the British Council for Offices award. Its inclusion is to illustrate where the energy benefits occur in a low energy mixed mode ventilated building as compared to a typical and good practice air-conditioned building. No breakdown cost data existing for the building in use. Note Fabers have used typical and good practice air-conditioned offices as a comparison.



Appendix F: CFD and Thermal Modelling

CAMBOURNE BUSINESS PARK

COMPUTER MODELLING - OFFICES AND ATRIUM
- SCHEME DESIGN STAGE -

Prepared by: ....
Ross Bates
Engineer

Approved by: ....
Neil Burns
Director

Job No:
Reference:
Date created:

Telephone: +44 (0) 20 8784 5784
Fax: +44 (0) 20 8784 5700
Website: http://www.fabermaunsell.com

Marlborough House
Uppe FABER MAUNSEL
St Albans
Hertfordshire AL1 3UT

CONTENTS

Appendices

1 Introduction

1.1 BACKGROUND

FaberMaunsell was commissioned to model the scheme design of South Cambridgeshire District Council (SCDC) offices situated in Cambourne Business Park. The design has a central atrium with office blocks either side, each block has three floors. The offices are situated so that the main facades face South East and North West. All the offices are modelled as open plan and are open onto the atrium. First and Second floor office blocks are connected to each other by means of bridges crossing the atrium at each of the levels.

The offices will be cooled by means of a mixed mode system; natural ventilation during mid-season supplemented by displacement ventilation during peak periods of winter and summer. The natural ventilation will be achieved by automated perimeter louvres located at high level in the offices and automated louvres located at high level in the atrium for exhaust. The mechanical displacement ventilation system will supply cooled air via floor plenums to the office areas (inclusive of atrium bridge areas) during peak summer. The system will also be used to provide ventilation with heat recovery during the winter. As well as performance benefits, the use of displacement ventilation during peak winter and summer conditions reduces the risk of localised discomfort in the perimeter zones.

1.2 OBJECTIVE

The objective of the modelling is to assess the performance of the scheme design against the latest building specification (revision V). The four identified assessment criteria are:

a) **The maximum space summer dry bulb temperature should not exceed 25°C.**
b) The chillers should not run for more than 300 hrs in an average year (not including IT and other specific requirements).
c) When operating solely in natural ventilation mode (displacement ventilation system disabled) the space dry resultant temperature should not exceed 25°C for more than 5% of the occupied period (130 hours).
d) The average daylight factor (DLF) should be at least 2% over 80% of the office space to comply with the BREEAM requirement.

1.3 ANALYSIS TOOLS

The analysis tools used to assess the thermal performance of the building are Dynamic Thermal Modelling and Computational Fluid Dynamics. For the dynamic thermal analysis FaberMaunsell uses is ModelIT, which is able to model the dynamic behaviour of buildings taking into account the internal and external gains as well as the thermal mass of the building fabric. This allows bulk temperatures (based on fully mixed condition) and loads to be determined. The dynamic thermal model has been used to predict dry resultant temperatures and also confirm the chiller run time for the cooling season.

Computational Fluid Dynamics (CFD) is able to analyse in detail air temperatures and velocities in and around buildings. FaberMaunsell uses FLOVENT, which is an established CFD package developed specifically for building services related applications.

CFD was used to provide a more detailed assessment of internal conditions, including temperature stratification and air movement. The CFD was also used to verify the sizing and opening regime for the louvers for natural ventilation.

The daylight factor was analysed using Radiance, which is produced by the Lawrence Berkeley Laboratory. Radiance can be used for the analysis of natural daylight and/or artificial lighting. Various sky models are available, but for daylight factor analysis, a CIE standard overcast sky is used.

2 Building Modelling

2.1 DYNAMIC THERMAL ANALYSIS

The basis of the dynamic thermal model is detailed in this section. It has been used for three analyses:

1. Design day calculation to assess performance on a peak summer day
2. Simulation to assess the summer performance of the mixed mode system
3. Simulation to assess the summer performance of the building operating solely in natural ventilation mode (displacement ventilation system disabled)

2.2 CLIMATE

Design day calculation: Maximum external ambient of 28°C db, 20°C wb

Simulations: The dynamic thermal model utilises a standard CIBSE example weather data for Heathrow 1979, the standard example year upon project commencement. (NB The simulation was undertaken over a 6-month period from May to October – the cooling season).

2.3 CONSTRUCTION

A three dimensional model of the building has been constructed based on the following Architects Drawings No's:

4245/PL/10010 rev -	4245/PL/10014 rev -
4245/PL/10011 rev -	4245/PL/10020 rev -
4245/PL/10012 rev -	4245/PL/10021 rev -
4245/PL/10013 rev -	4245/PL/10025 rev -

Externally the dynamic thermal model visually represents the complete building, taking account of self-shading for the solar loading and daylight assessments the ModelIT construction file was exported to Radiance for the daylight assessment). However internally only the offices and connecting atrium areas have been assessed. The cores, stair wells and council chambers are excluded from the current analysis. The office floor to ceiling height is 3.2m and the slab-to-slab height is 3.8m. The ceiling slab is exposed heavyweight concrete. The building fabric construction and U-values are detailed in Appendix A.

The building orientation is 51° from North, There are two blocks of offices; three floors to each block located either side of a central atrium. The offices have been modelled as open plan. The ground floor is open to the atrium. Levels one and two have opaque up-stands at 1.1m high between the offices and the atrium.

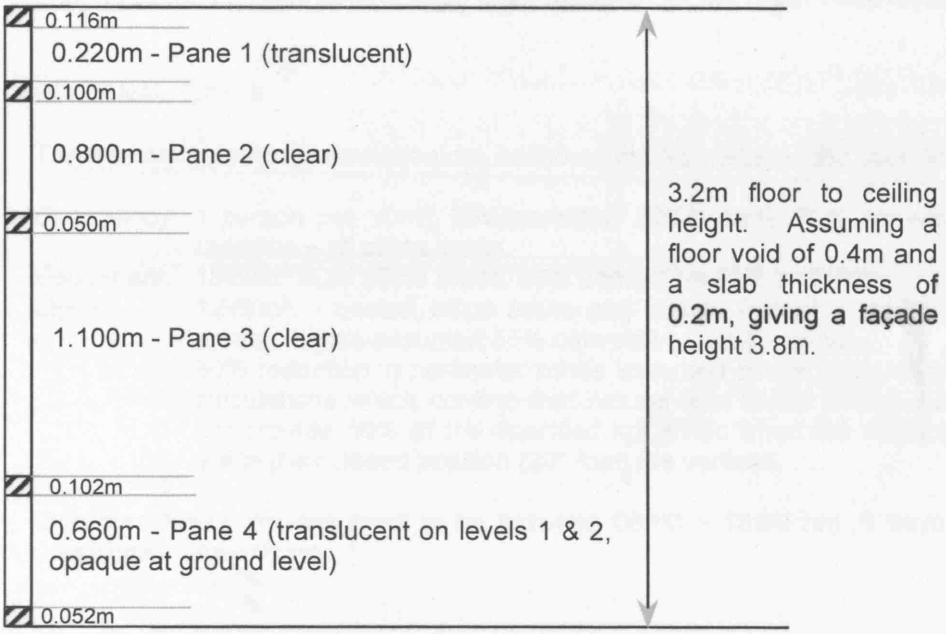
Each floor of office has been split into two zones, a 6m strip along the perimeter and the remaining central office area.

All office glazing facing South East is to be clear Low E double glazed units. All other vertical clear double glazing, is to be solar controlled (inc. the atrium clear vertical glazing). All translucent panels will use SGG Plani-star, Opalit Neutral (SGV 80000) double glazed units. These are assumed to be located as detailed in the glazing summary contained in Appendix A.

The roof lights are to be SGG Parsol Ford Blue, Planitherm Neutral (Low E) double glazed unit.

Glazing details are specified in Appendix A. All properties are as the Saint Go-Bain Glass Guide, or have been supplied direct from the manufacture.

South East Elevation



Note: The elevation shows the dimensions used in the model. In reality the transoms may vary in dimensions and location. The results will be valid as long as the glazing areas are maintained together with an equivalent level of shading.

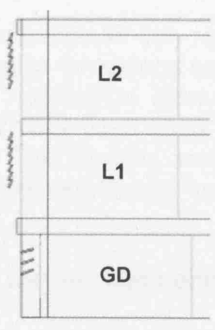
Some shading is provided by the physical shape of the building, including plant rooms and council chambers. There are three other types of shading devices, fixed louvres, mechanically controlled shading louvres and roof overhangs. The amount of shading louvres varies in order to meet the design criteria.

- South West and South East corner of atrium, ten 500mm horizontal fixed shading louvres per bay positioned as per Dwg. No's. 4245/PL/10021 and 4245/PL/10025.

- South East elevation levels 1 and 2, 7 solar controlled shading louvres per bay positioned as per Dwg. No's. 4245/PL/10021 and 4245/PL/10025, with two extra shading louvers added to each level (elevation wise). The shading louvers will mechanically track the sun. For simulation purposes all 14 (7 per level) are modelled at 20° to the vertical.

- South East elevation ground floor, three 480mm fixed shading louvres per bay positioned 20° from the horizontal as per Aukett fax dated 260302 Ref 4245, filing ref. B4. The ground floor also benefits from shading provided by the structural columns and the overhang.

South East Elevation



- Roof shading, solid panel and louvres at 60° as per Dwg. No. 4245/PL/10014.

The impact of any temperature pick up from the shading louvres on the South East facade has been assumed to be minimal. Design of the façade and shading louvres will aim to minimise pick up. Due to the building orientation, the shading louvres would be irradiated by morning sun when the solar intensities are not at their peak. In additional, any pick-up will also not generally coincide with peak gains within the offices. (NB Any pick-up would only impact on the performance of the natural ventilation.)

Internal blinds for glare control have been modelled for the North West façade.

2.4 INTERNAL GAINS

The internal gains are detailed below, based on figures stated in the specification.

Occupancy: 1 person per 10m², 90W(sensible) 50W(latent), 30% convective 70% radiative – all office areas.
Equipment: 15W/m² to all office areas, 80% convective 20% radiative.
Lights: 12W/m² - central office areas and atrium, 6W/m² - perimeter office areas. Lights assumed 55% convective 45% radiative.
50% reduction in perimeter zones assumed on the basis of daylighting calculations which confirm that natural light levels will be sufficient to still provide 50% of the specified lux levels when the shading louvres are in their closed position (20° form the vertical).

Occupied hours are assumed to be between 08:00 – 18:00 hrs, 5 days a week, unoccupied at weekends.

2.5 DISPLACEMENT VENTILATION SYSTEM

The displacement ventilation system is modelled to supply air at 18°C to the office areas and connecting bridges in the atrium via the floor plenum. No air is supplied directly to the atrium floor area. The atrium occupied area benefits from the overspill from the office displacement ventilation (no upstands are present between the ground floor and the atrium).

The minimum outdoor air supply rate is 1.6 l/s/m² per each occupant. For cooling purposes the system supplies an average of 4 l/s/m², weighted towards the perimeter zones that experience higher gains (solar).

The displacement ventilation system operates during the occupied period when the ambient temperature exceeds 20°C. Air is supplied to each of the zones at 18°C.

2.6 NATURAL VENTILATION SYSTEM & INFILTRATION

The natural ventilation system has been designed to provide an average air flow rate of 4 l/s/m² during the day and night. Sizing of the louvres at design conditions was undertaken using calculation procedures specified in CIBSE Application Manual AM10 (Natural ventilation of non-domestic buildings, 1997). CFD has been used to verify the opening regime and sizing of the ventilation louvres. The opening areas will be modulated to control air flow rates as conditions and the driving forces vary from design.

A continuous infiltration rate of 0.25 ACH has been included for the perimeter office zones and the atrium.

The natural ventilation system operates during the occupied period when the ambient temperature is below 20°C. Ambient air is introduced into the perimeter zones and transfers to the internal zones. (NB In practice there will be instances due to high wind / driving rain when the natural ventilation system will need to be held off and the displacement system will operate.)

The natural ventilation system also operates out of hours (18:00 – 08:00 hrs weekdays + weekend) to provide "night cooling" when the following conditions are met:

- Previous occupied days peak temperature exceeds 23°C
- Internal temperature is above 18°C.

2.7 CFD ANALYSES

CFD analyses have been undertaken for the following cases:

1. Natural ventilation to verify the louvre sizing and opening regime
2. Displacement ventilation to analyse temperature distribution and stratification

The model is for an open plan office based on the construction detailed in Section 2.2. The perimeter and atrium louvres are modelled, the glazing and detailed façade geometry have not been modelled. Sizing of the louvres was undertaken using calculation procedures specified in CIBSE Application Manual AM10 (Natural ventilation of non-domestic buildings, 1997).

Each 6m office bay has four automated louvres at high level. All manual windows and doors have been assumed to be closed for the purposes of this assessment. (NB The desired operation of the manual windows has yet to be detailed. Opening dimensions are likely to be optimised to the minimum to maximise the effective balancing of the system.)

Preliminary results demonstrated the need for the atrium louvres to be distributed at high level along either side of the atrium for stack driven ventilation to be effective on Level 2. In the model the high level ventilation louvres in the atrium are equally distributed either side, there are 32 louvres positioned along the North West elevation (14.4m² free area of opening) and 32 louvres now positioned on the South East elevation (14.4m² free area of opening).

The solar loading was taken from the dynamic thermal model for the end of June when the sum of the direct solar intensities are at a maximum. A heat gain analysis was used determine convective solar gains to the space. These were then added as a convective element to the perimeter office space and the atrium together with the internal gain convective components.

The surface temperatures for the ceiling and floor were also taken from the dynamic thermal model. These account for the radiative element produced by the solar and internal gains. The remainder of the building fabric is assumed thermally neutral.

No infiltration has been included in the displacement ventilation model as the system will act to pressurise the building.

The natural ventilation analysis is based on 20°C db ambient temperature (displacement ventilation is available above this value). To balance the system the following opening regime for the perimeter louvres was used:

- Ground 3 out of 4 louvres per bay open
- Level 1 3 out of 4 louvres per bay open
- Level 2 4 out of 4 louvres per bay open

All high level louvres are open for no-wind condition

The displacement ventilation analysis is based on 28°C db ambient temperature, the summer design temperature. The displacement ventilation provides an average supply volume of 4l/s/m² at a supply temperature of 18°C. Perimeter louvres are closed. Atrium louvres are open for the no-wind condition.

2.8 DAYLIGHT ANALYSIS

The aim of the daylighting analysis was to demonstrate that the daylighting factors (DLF) are BREEAM compliant, ie greater than 2% over 80% of the office space. The assessment used a standard CIE overcast sky with no ancillary luminaires. The standard CIE overcast sky assumes diffuse radiation only. Consistent with an overcast sky, shading louvres have been modelled in the horizontal position, as no direct sunlight is present.

The building construction was imported from the ModelIT construction file used for the dynamic thermal simulation.

The shading louvres are polished aluminum, with a RGB value of 0.8 and secularity of 0.2. The office surface finishes are assumed matt with the following RGB values: Floor = 0.3, Ceiling = 0.8, Walls = 0.5. The glazing light transmissions are detailed in Appendix A.

The height of the working plane was taken 0.75m above each of the office floors. The results for the DLF throughout the space were converted into data files and the average DLF calculated.

An additional analysis was conducted to assess daylight levels in the perimeter zones when the louvres are closed (20° to the vertical). This was to demonstrate that the perimeter 6m zone is sufficiently lit by daylight (200 Lux), to justify the assumption that lighting gains in the perimeter zone for the heat gain assessment could be reduced to 50%. This is consistent with the Clients desire to minimize energy consumption and will be facilitated by the provision of a lighting control system. The analysis was undertaken for the upper South East Level One office (lowest DLF from the BREEAM calculation assessment) using a Sunny Sky (21st December at 11:00 hrs - low sun angle).

It should be noted that the lighting assessments have been conducted without any internal blinds present. The Architect has yet to develop his proposals.

3 RESULTS

3.1 THERMAL MODEL

3.1.1 Design Day

The average dry resultant temperature does **not exceed 25°C in any of the occupied** zones during the occupied period.

3.1.2 Simulation of the mixed mode system

The mixed mode model does not exceed 25°C (average dry resultant temperature) in any of the occupied zones during the occupied period.

Mechanical cooling is predicted to be required for approximately 240 hrs per year, thus less than the maximum of 300 hrs stated in the design brief.

3.1.3 Simulation with natural ventilation only

For all zones the number of hours that the average dry resultant temperature **exceeds 25°C is less than 130 hours (5% of** the year). The results are included in the Table below.

System Simulation summer period	
Zone Type	Natural Ventilation System Only No. Hours 25°C Dry Resultant Temperature is Exceeded / Hrs P.A. Ref16
South East Perimeter Office Zone, Ground Floor	54
South East Perimeter Office Zone, Level One	83
South East Perimeter Office Zone, Level Two	83
South East Main Office, Ground Floor	51
South East Main Office, Level One	60
South East Main Office, Level Two	60
North West Perimeter Office Zone, Ground Floor	46
North West Perimeter Office Zone, Level One	57
North West Perimeter Office Zone, Level Two	59
North West Main Office, Ground Floor	36
North West Main Office, Level One	37
North West Main Office, Level Two	36
Central Atrium	29

Exceed 25°C for 5% of occ. Period - 10(hrs) * 5(days) * 52(weeks) * 0.05(%) = 130hrs

3.2 COMPUTATIONAL FLUID DYNAMICS

The CFD results are contained in Appendix B.

3.2.1 Natural ventilation model

The results demonstrate that the natural ventilation system will maintain comfort temperatures in the occupied zone below 25°C (Comfort temperatures are comparable to dry resultant temperatures used in the dynamic thermal modelling, differing by making an adjustment for calculated air movement). This is for a calm day with an ambient temperature of 20°C. Wind will augment the performance of the system. (NB The displacement ventilation system will normally operate when the ambient temperature exceeds 20°C.)

3.2.2 Displacement ventilation model

The displacement ventilation results illustrate temperature distribution / stratification within the space. This shows the comfort temperatures within the occupied space to be well below the maximum design temperature of 25°C. (NB the dynamic thermal model provides a worst case mixed air scenario, the CFD results illustrate how much improvement can be expected from achieving a displacement air flow regime.)

3.3 DAYLIGHT ASSESSMENT

The daylighting analysis demonstrates that the daylighting factors (DLF) are greater than 2% on average over 80% of the total office space.

Based on a sunny sky with louvres located in the vertical position, the daylight levels experienced in the South East Levels 1 and 2 perimeter office zones are on average 200 Lux, supporting the assumption that lighting gains can be assumed to be reduced to 50% in these zones.

4 CONCLUSION

The analyses demonstrate that the building meets the identified performance criteria.

An even distribution of the louvres at high level in the atrium is necessary for the natural ventilation system to be effective.

The results are for open plan offices. Cellularisation will impact on the effectiveness of the natural ventilation system. The amount of Cellularisation should not exceed the guidelines set out in our document ref: GAB14032002L1, dated 14th March 2002.

Modelling of other options during this process has also demonstrated that improvements to the envelope performance could be achieved by replacing the translucent panels at low level on the SE Levels 1 and 2 with opaque insulated panels and also reduce the number of shading louvres from 7 to 5. This would significantly improve daylight levels at the working plane within the perimeter zones on levels 1 and 2 on the south east facade. The tranluscent panels at low level make no significant contribution to daylight levels at the working plane, while contributing significantly to unwanted solar gains during the summer. Reducing the number of shading louvres admits more daylight onto the working plane therefore improving daylight factors. Preliminary thermal analysis shows that the additional solar gain from removing the louvers is offset by the benefit from removing the translucent panel.

Appendix A – Construction Details

It should be noted that the U-value is the most influential factor compared to the actual construction materials and relevant thickness. The fabric constructions and the overall U-values are detailed below. The Architects supplied the U-values for the glazing, in order to comply with part L regulations the U-values should be inclusive of glazing and framing.

Material | ***Dimensions*** | ***U-Value***

Transparent

Low E dg unit (6-16-6mm) (~ U-value = 1.8 W/m²C)
SGG Planilux (clear float) Solar Tran : 47%
Air gap Light Tran: 75%
SGG Planitherm Neutral (Low E)

Solar control dg unit (6-16-6mm) (~ U-value = 1.8 W/m²C)
SGG Cool-lite SKN 172 - Solar Tran : 36%
- Neutral (solar ctl) Light Tran: 66%
Air gap
SGG Planilux (clear float)

Translucent Panel (6-16-6mm) (~ U-value = 1.8 W/m²C)
SGG Plani-star Solar Tran : 31%
Air gap Light Tran: 44%
SGG Opalit Neutral

Roof lights (6-16-6mm) (~ U-value = 1.8 W/m²C)
SGG Parsol Ford Blue Solar Tran : 29%
Air gap Light Tran: 47%
SGG Planitherm Neutral (Low E)

Opaque

Internal ceilings and floors (~ thickness 0.6m) (~ U-value = 1.2 W/m²C)
(Assumed Construction)
Carpet (0.005m)
Flooring (0.025m)
Air Plenum
Cast Concrete **(0.20m – solid construction, density of 2100 kg/m³)**

Roof (~ thickness 0.6m) (~ U-value = 0.25 W/m²C)
Bitumen Layer (0.05m)
Concrete (0.2m)
Insulation (0.075m)
Cast Concrete (0.20m – solid construction))

Ground Floor (~ thickness 0.7m*) (~ U-value = 0.22 W/m²C)
London Clay (1.0m) (* Clay layer excluded from thickness cal.)
P.V.C. (0.005m)
Insulation (0.06m)
Cast Concrete (0.20m – solid construction))
Air Plenum
Flooring (0.05m)
Carpet (0.005m)

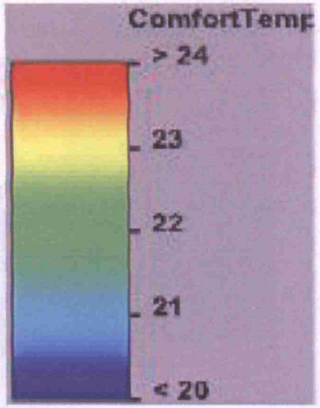
Aluminium Cladding (~ thickness 0.3m) (U-value = 0.3 W/m²C)
Lightweight Aluminium (0.003m)
Insulation (0.12m)
Lightweight Aluminium (0.003m)

Glazing Area Summary (per 6m bay):

Please refer to glazing specifications provided in construction details above

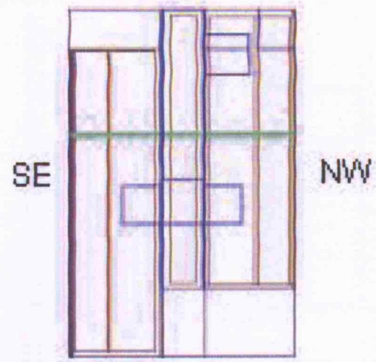
South East Ground:	Pane 1 - Translucent panel, area = 1.1m²
	Pane 2 - Low E dg unit, area = 4.0m²
	Pane 3 - Low E dg unit, area = 5.5m²
	Pane 4 - Opaque Solid
South East L1 & L2:	Pane 1 - Translucent panel, area =1.1m²
	Pane 2 - Low E dg unit, area = 4.0m²
	Pane 3 - Low E dg unit, area = 5.5m²
	Pane 4 - Translucent panel, area = 3.3m²
North West Ground L1 & L2:	Pane 1 - Opaque Solid
	Pane 2 - Solar control dg unit, area = 4.0m²
	Pane 3 - Solar control dg unit, area = 5.5m²
	Pane 4 - Opaque Solid
Atrium:	Upper louvers (Translucent panel), area = 2.5m²
	All vertical glazing - Solar control dg unit
	Double glazed units at top, area = 7.5m²
	4 Roof lights, area = 24.3m² (each)

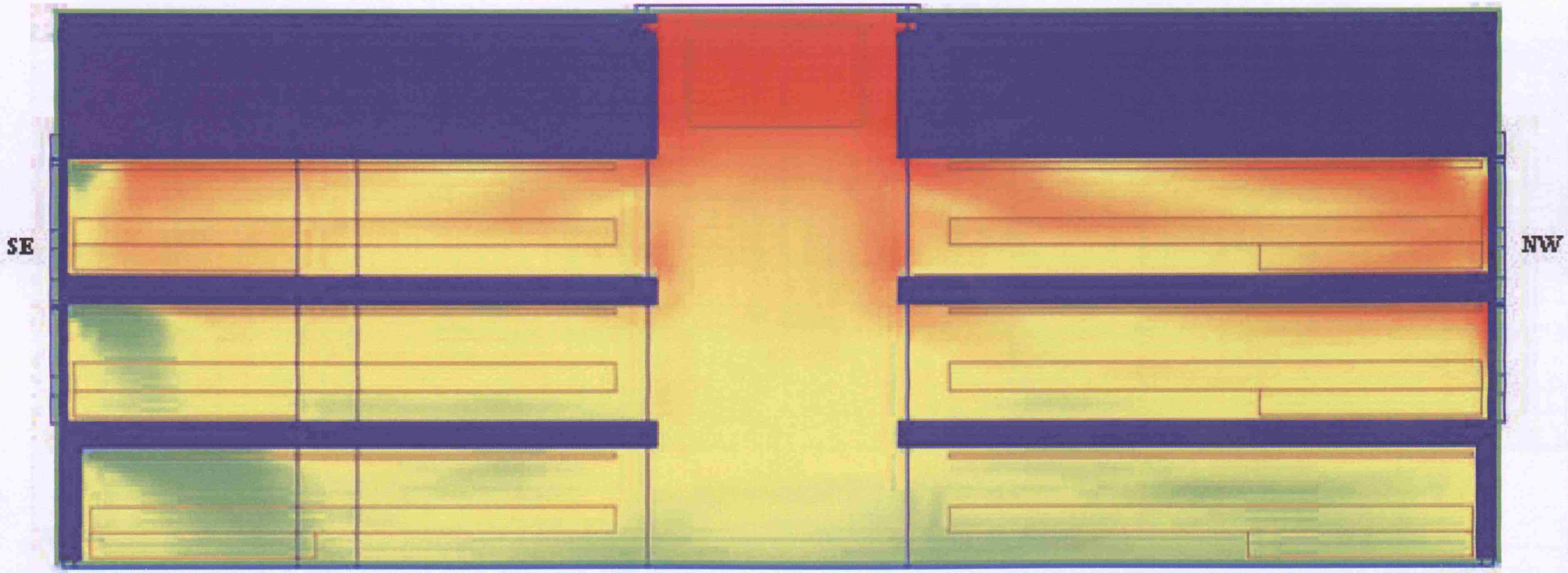
Natural Ventilation Option



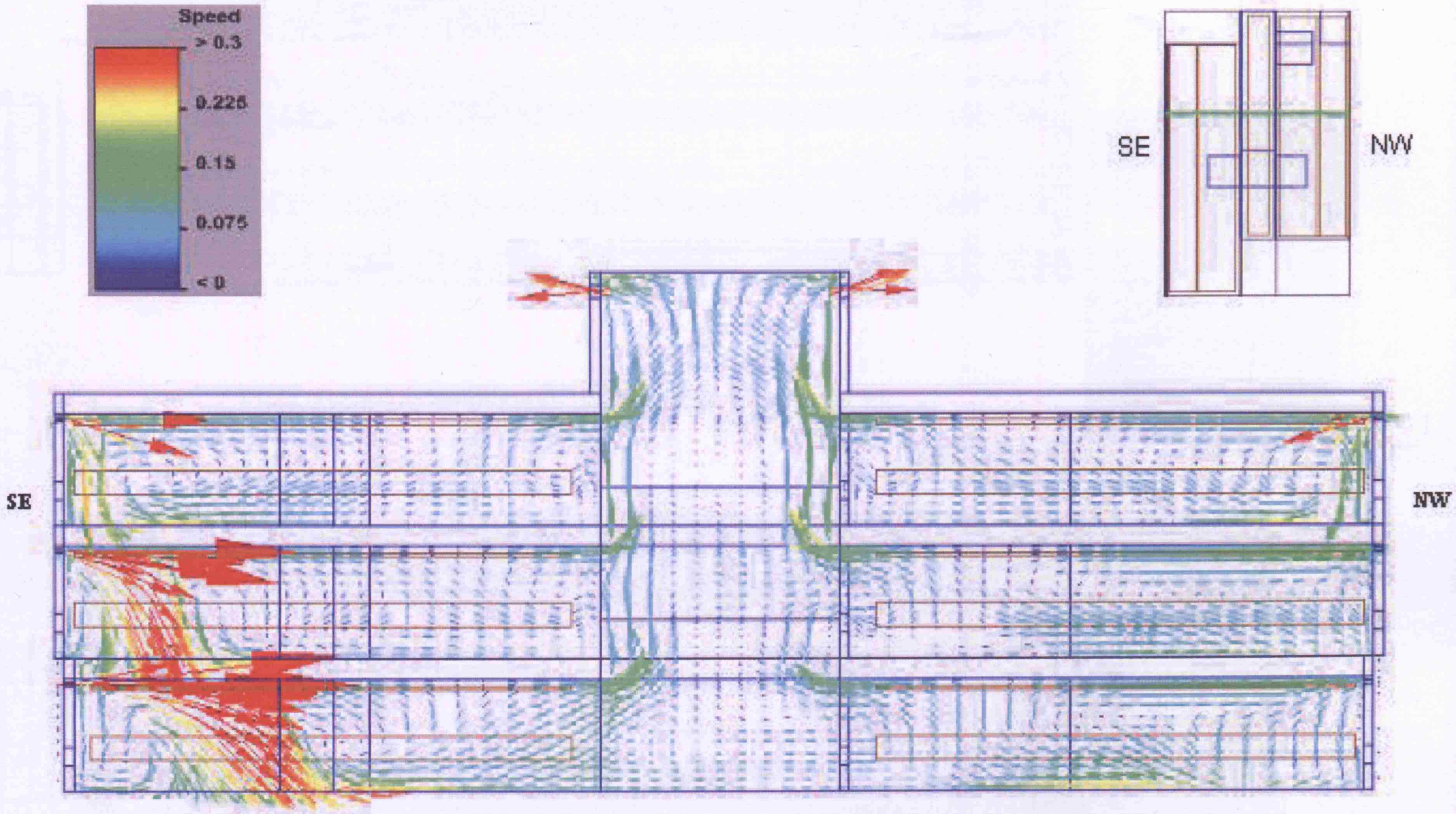
Opening regime:

Ground Floor: 3 inlets open.
Level 1: 3 inlets open.
Level 2: all 4 louvres open.
Atrium: All Outlet Louvres open





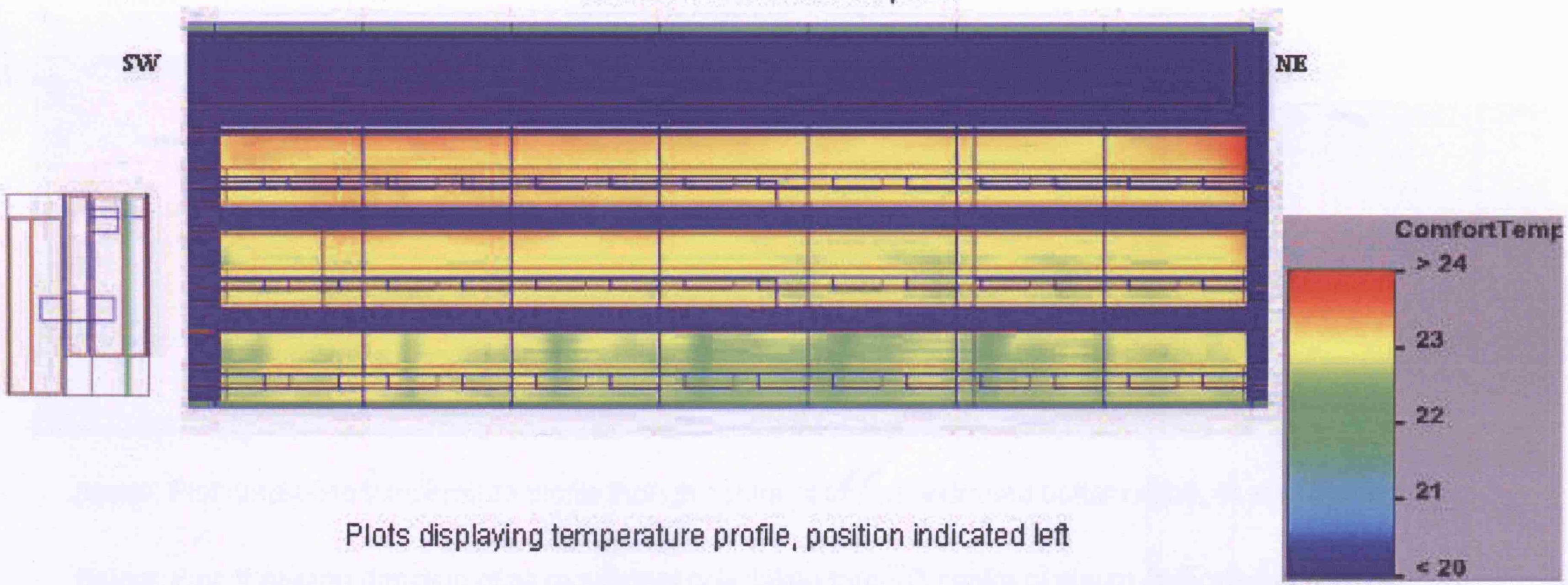
Temperature plot detailing profile, scale to left and position of plot indicated to the right.Occupied spaces below 25°C.



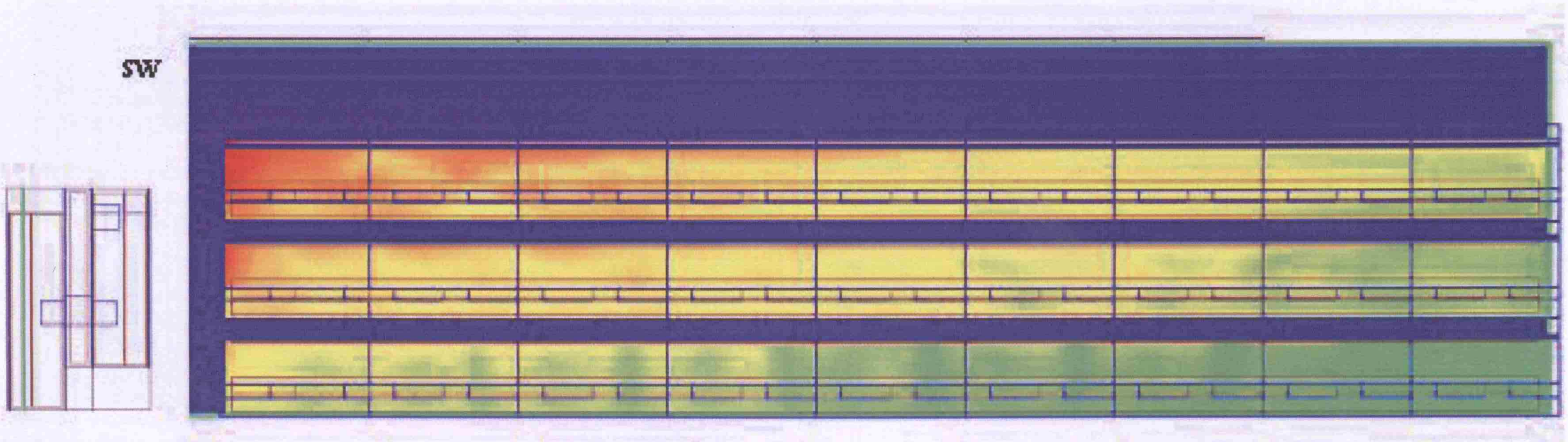
Above: Vector plot displaying speed and direction of air movement.

FABER MAUNSELL

Natural Ventilation Option

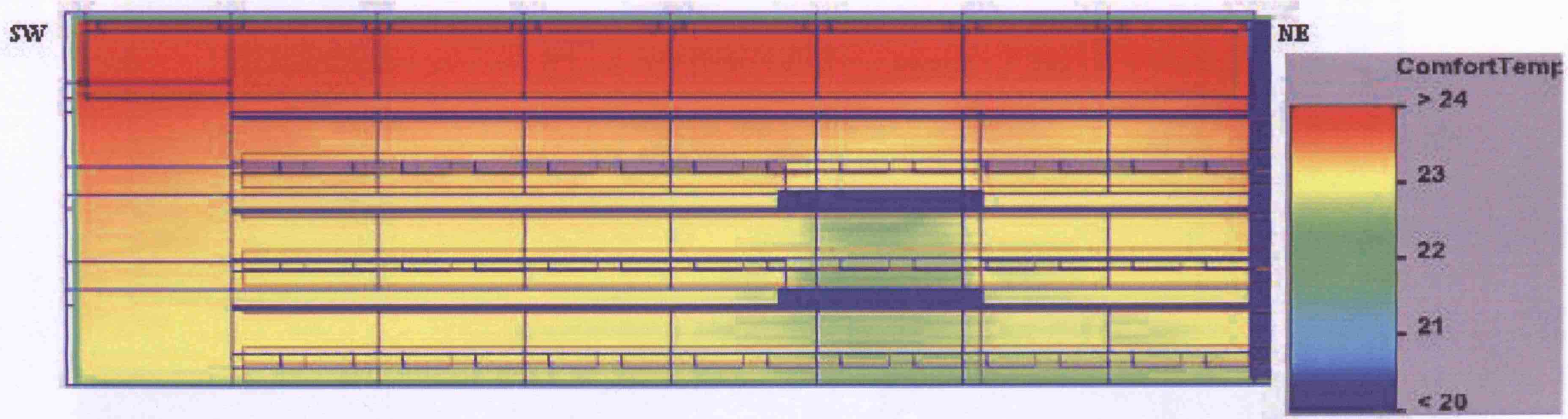


Plots displaying temperature profile, position indicated left



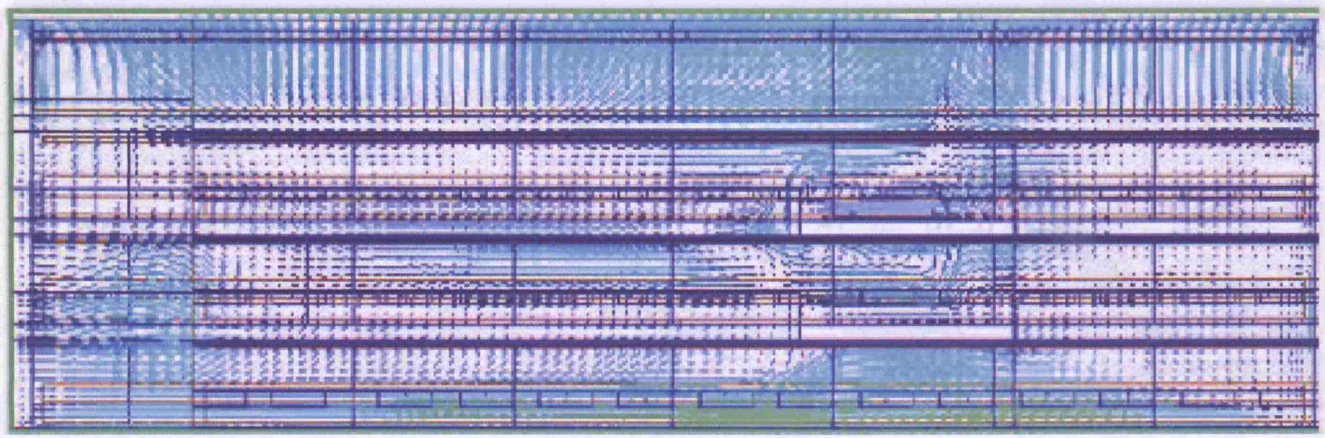
FABER MAUNSELL

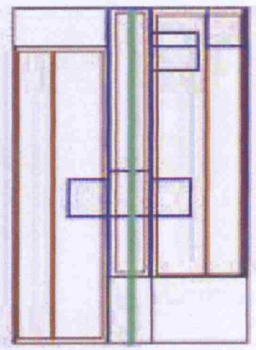
Natural Ventilation Option



Above: Plot displaying temperature profile though centre of atrium (indicated bottom right), scale indicated left.

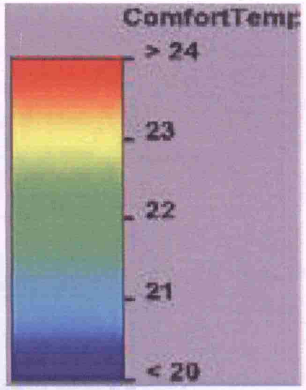
Below: Plot displaying direction of air movement only, taken through centre of atrium (indicated bottom right).





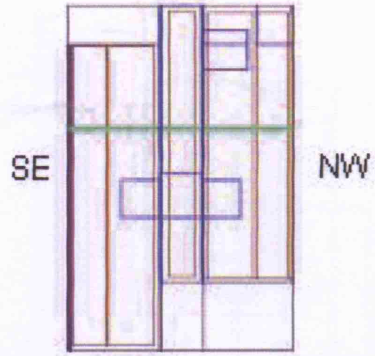
FABER MAUNSELL

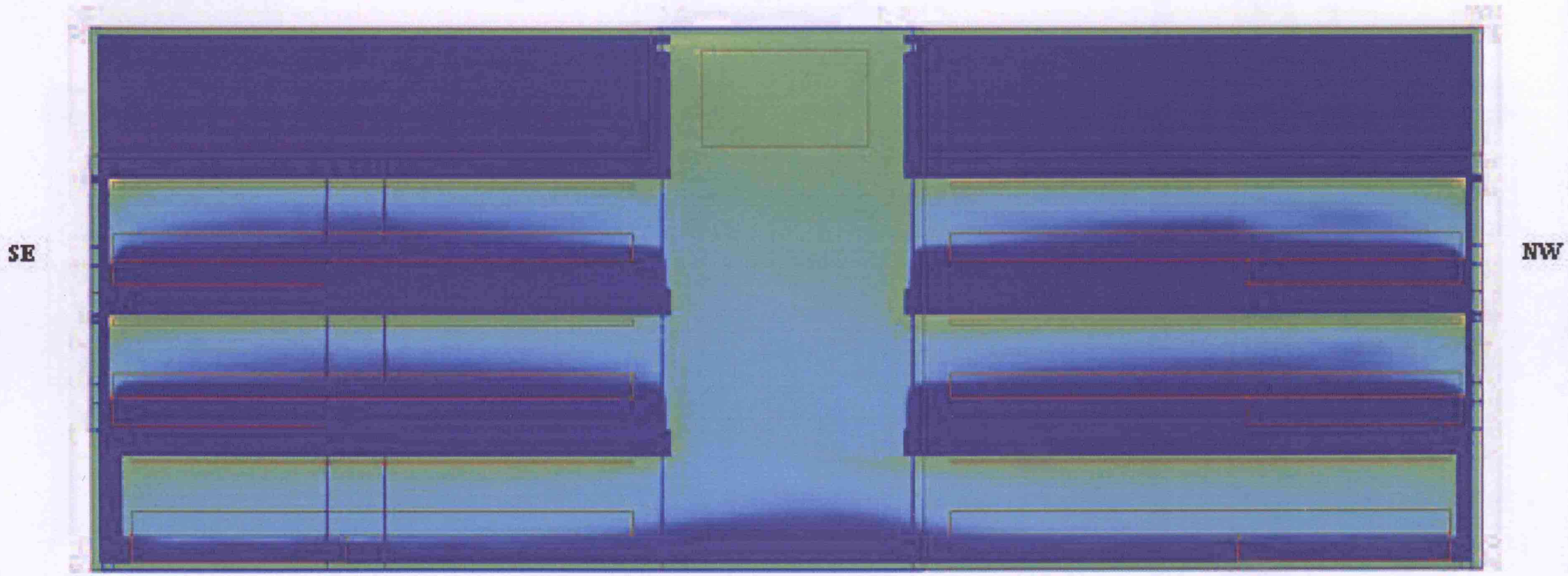
Mechanical Ventilation Option



Opening regime:

Atrium: All Outlet Louvres open.
All inlet openings louvres closed.

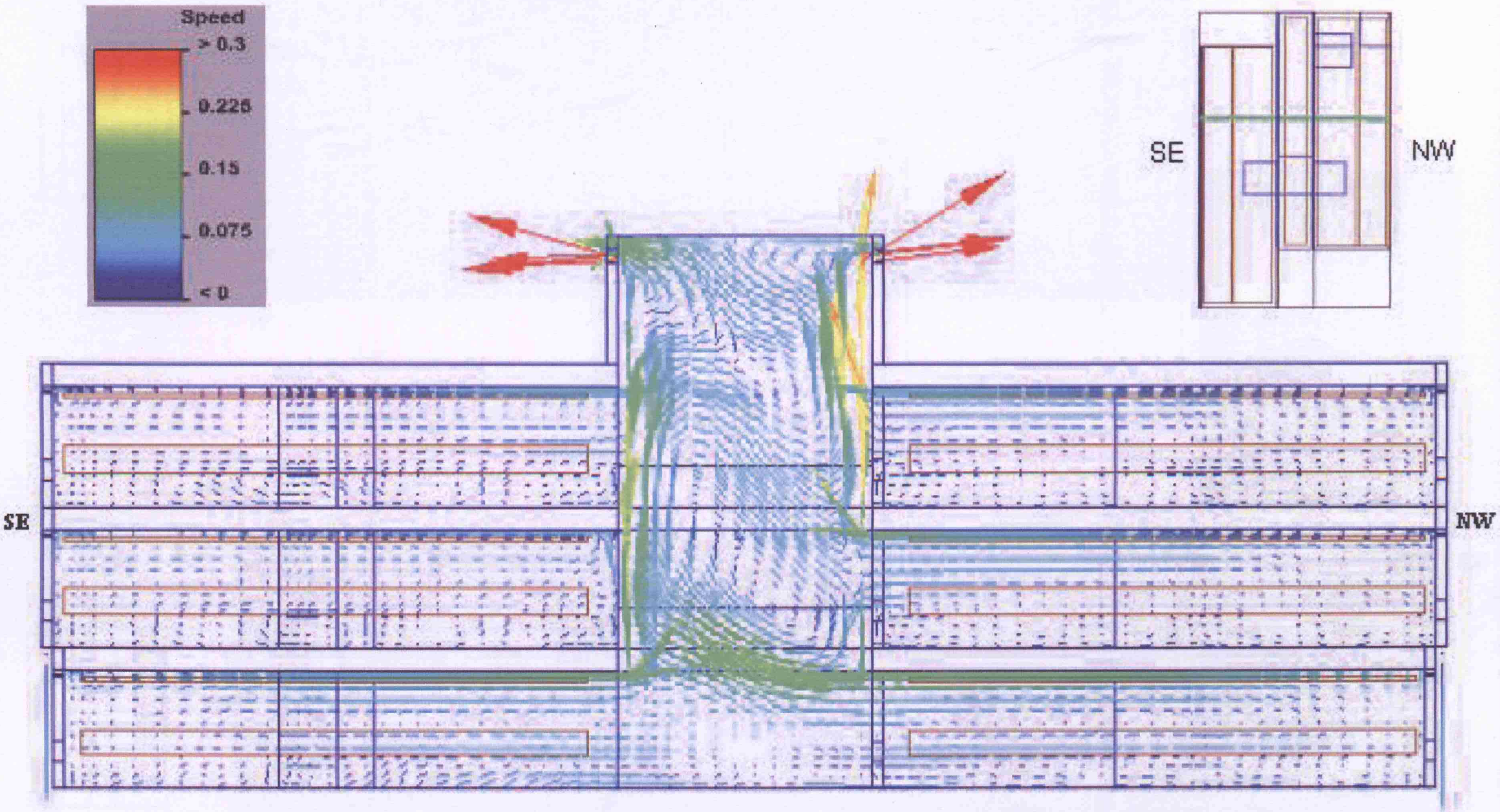




Temperature plot detailing profile, scale to left and position of plot indicated to the right.Occupied spaces below 25°C.

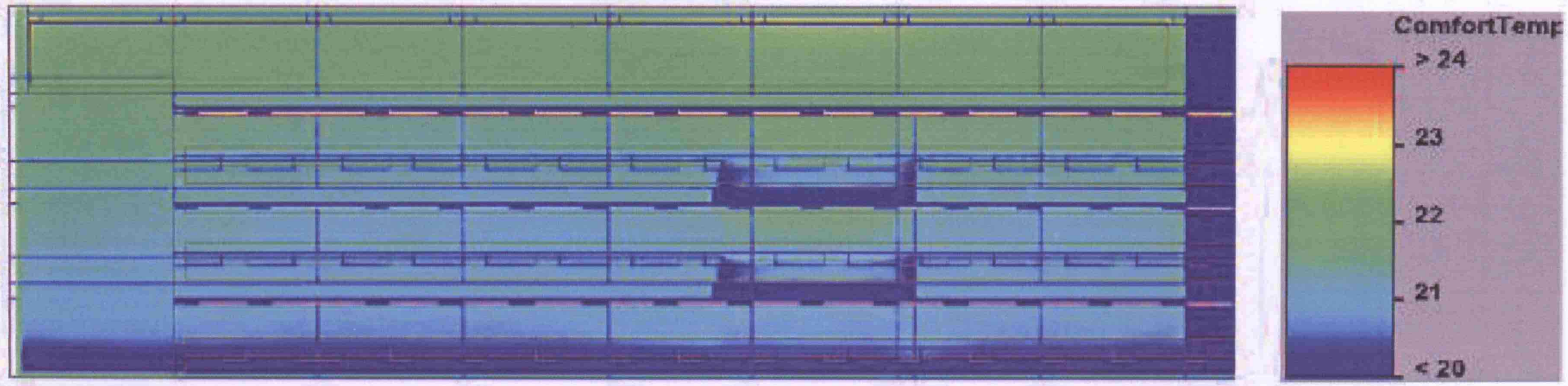
FABER MAUNSELL

Mechanical Ventilation Option



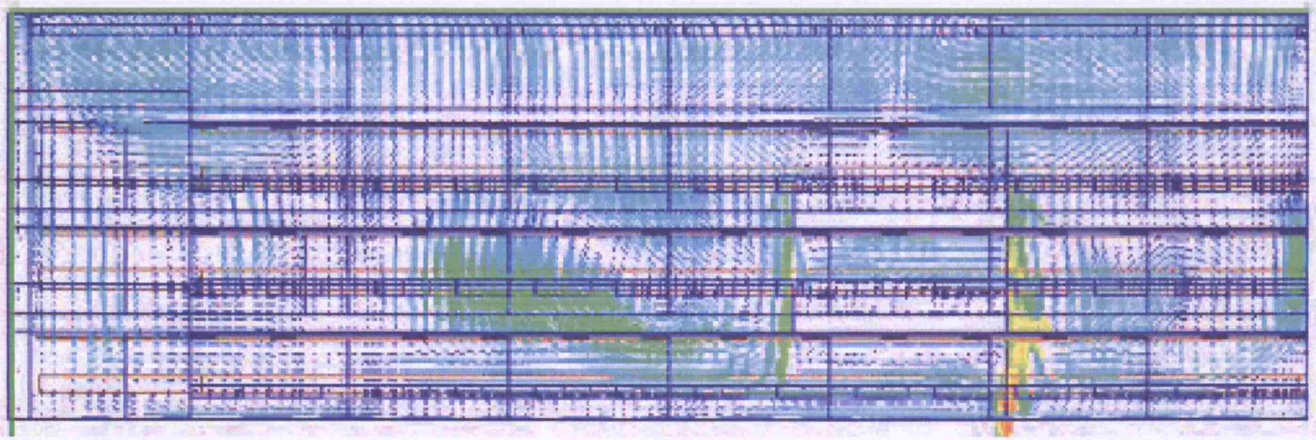
Above: Vector plot displaying speed and direction of air movement.

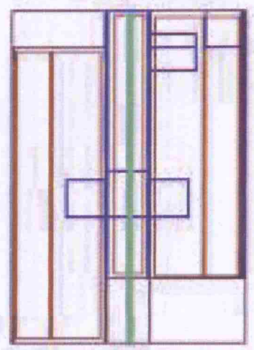
Mechanical Ventilation Option



Above: Plot displaying temperature profile though centre of atrium (indicated bottom right), scale indicated left.

Below: Plot displaying direction of air movement only, taken through centre of atrium (indicated bottom right).



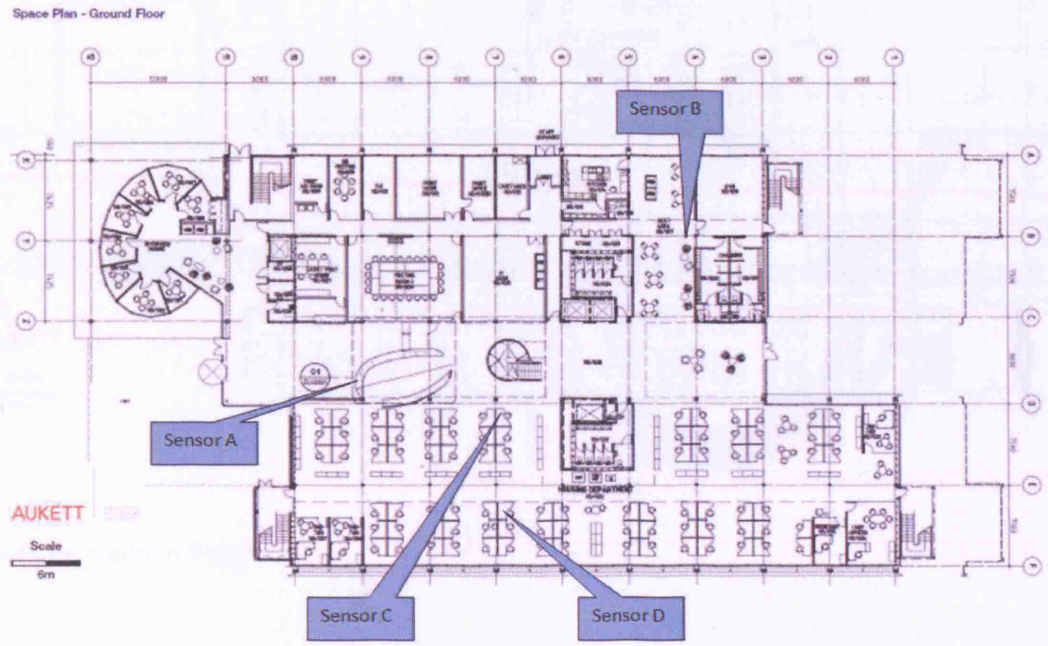


FABER MAUNSELL

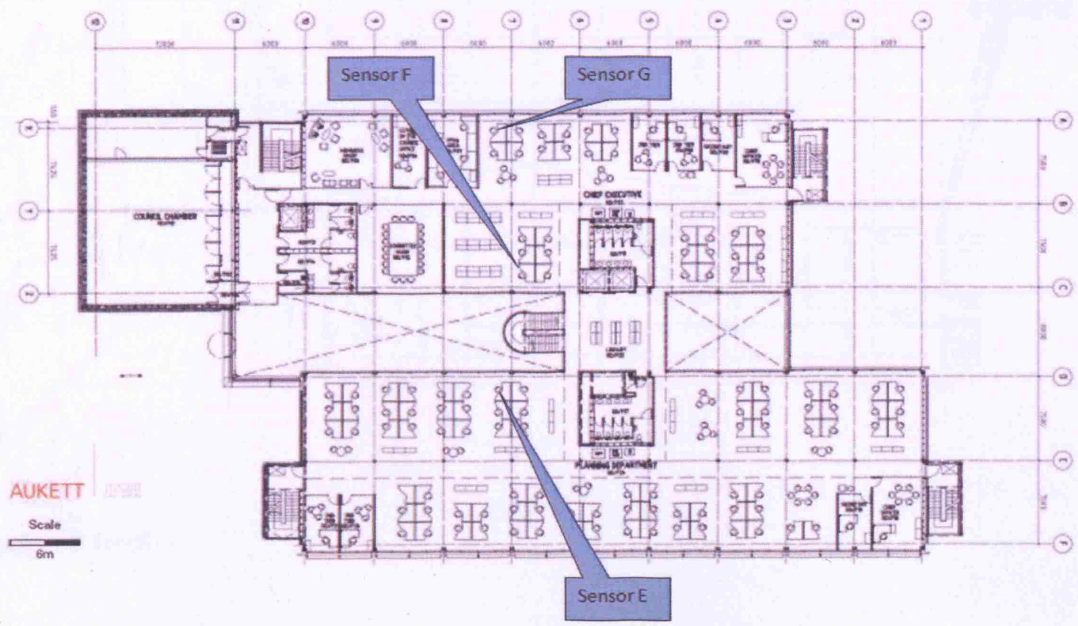
Appendix G: Sensor Graphs

Sensor Readings

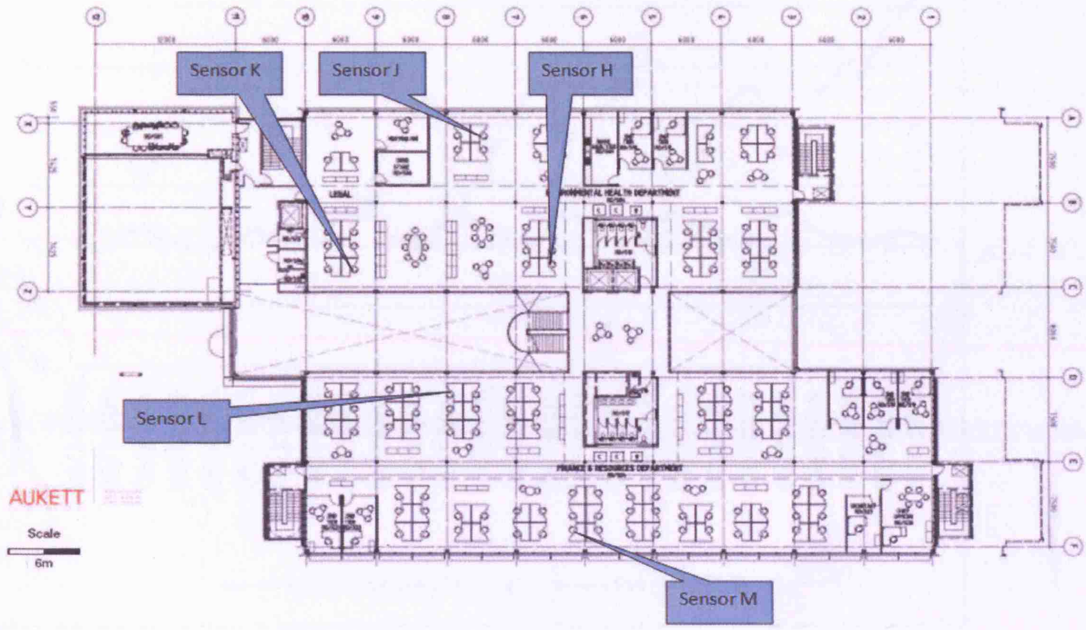
Summer: June 2008



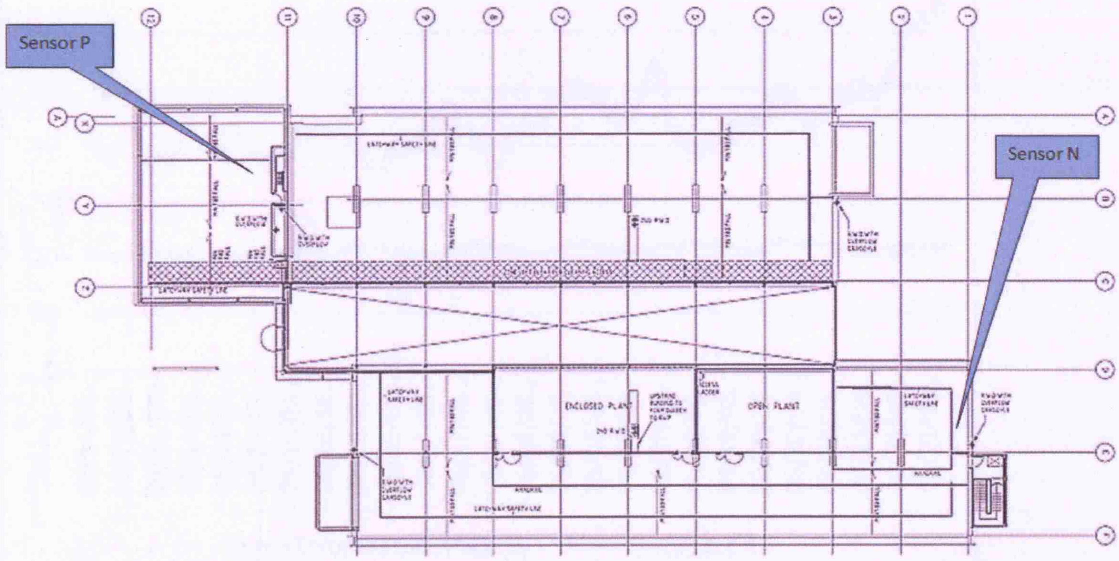
Key Plan: Ground Floor



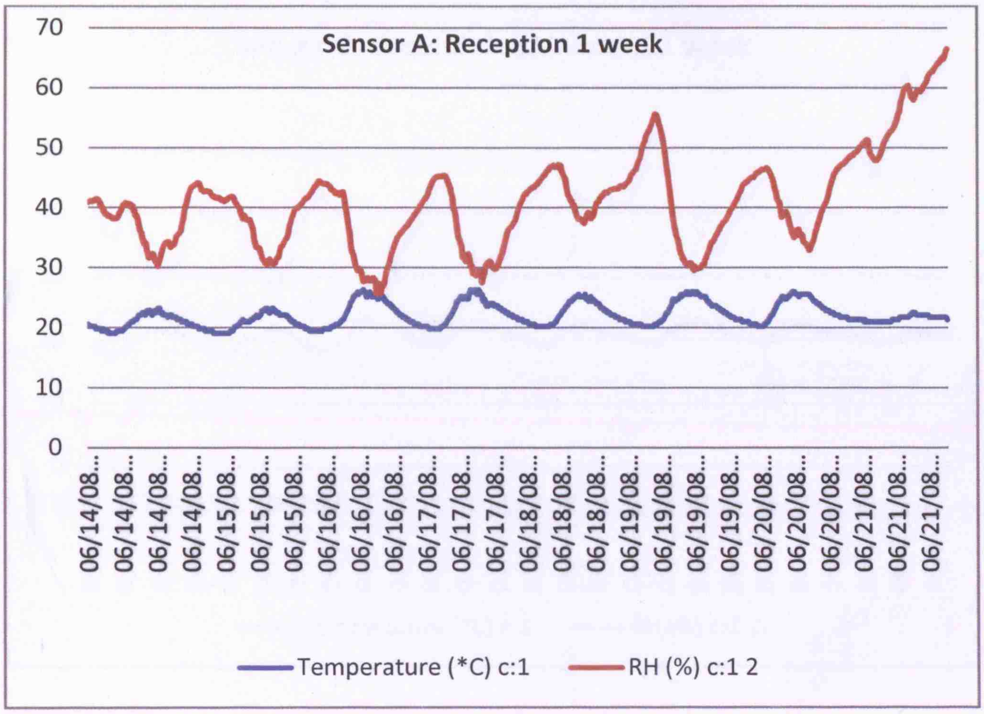
Key Plan: First Floor



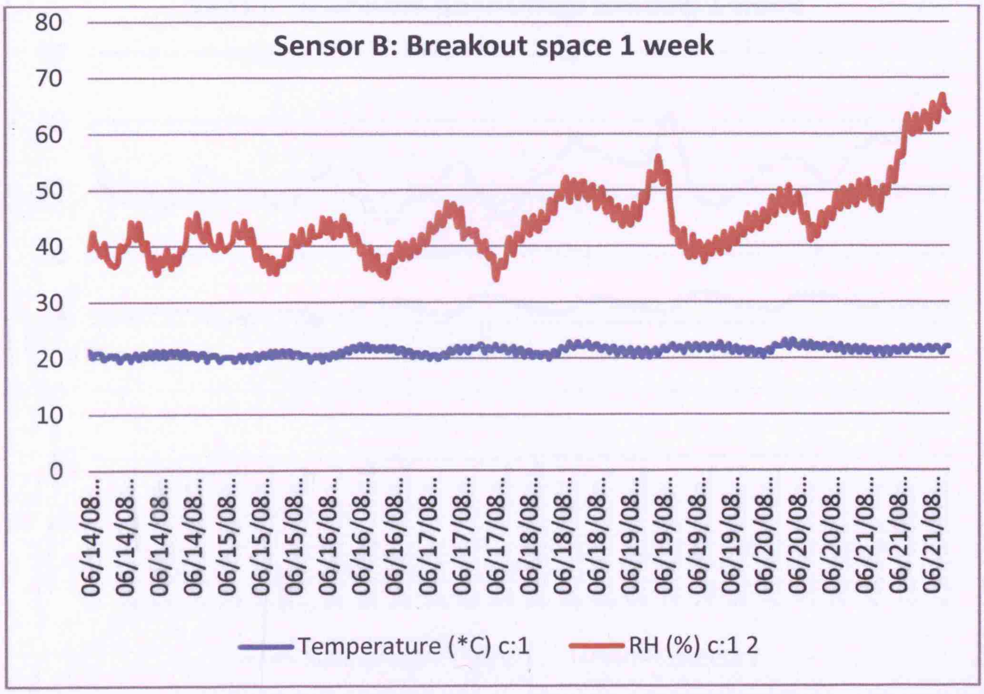
Key Plan: Second Floor



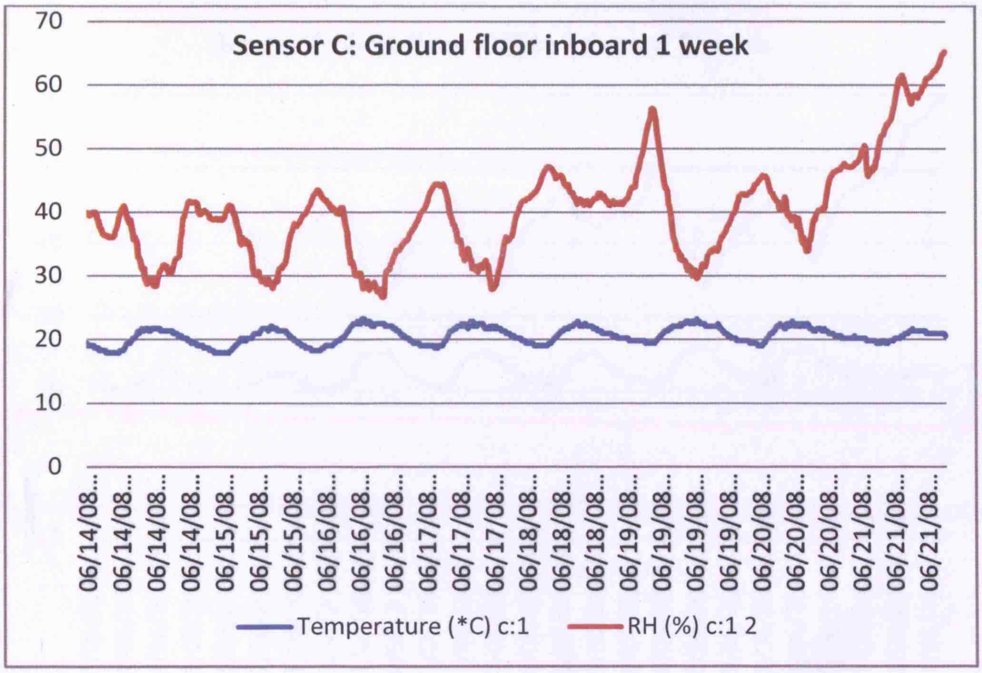
Key Plan: Roof



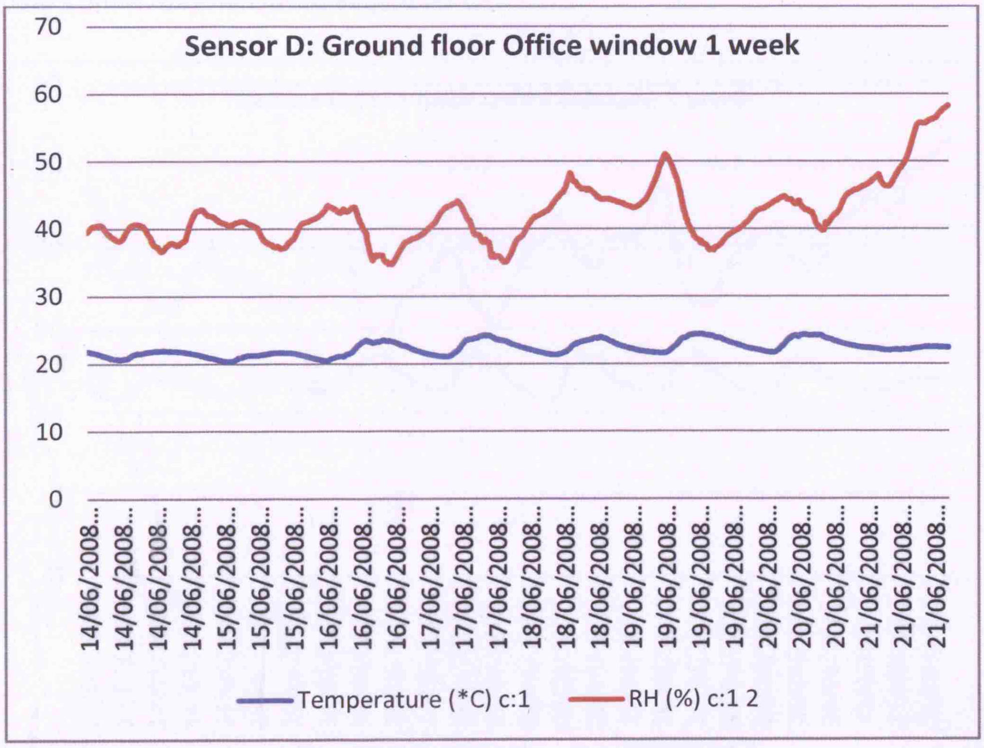
Reception has a smoother temperature swing than the winter readings showing the effect of the horizontal louvres shielding the building from the high sun. The temperatures are higher than the main office because of remoteness from the sensors and no cooling in the atria.



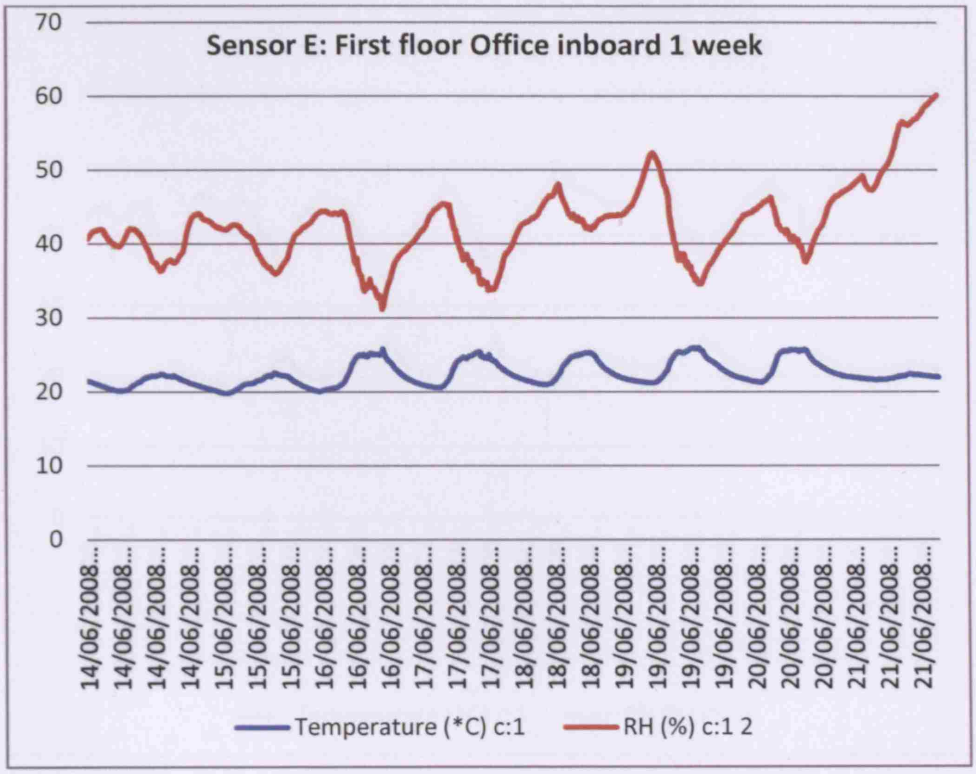
The most entertaining results were from the breakout zone. The sensor was located on the top of the drinks machine the oscillation cycle can be of the heating cycle can be clearly seen within a very steady temperature range As the breakout space has a low occupation density the temperature range is only slightly discernable from the weekend.



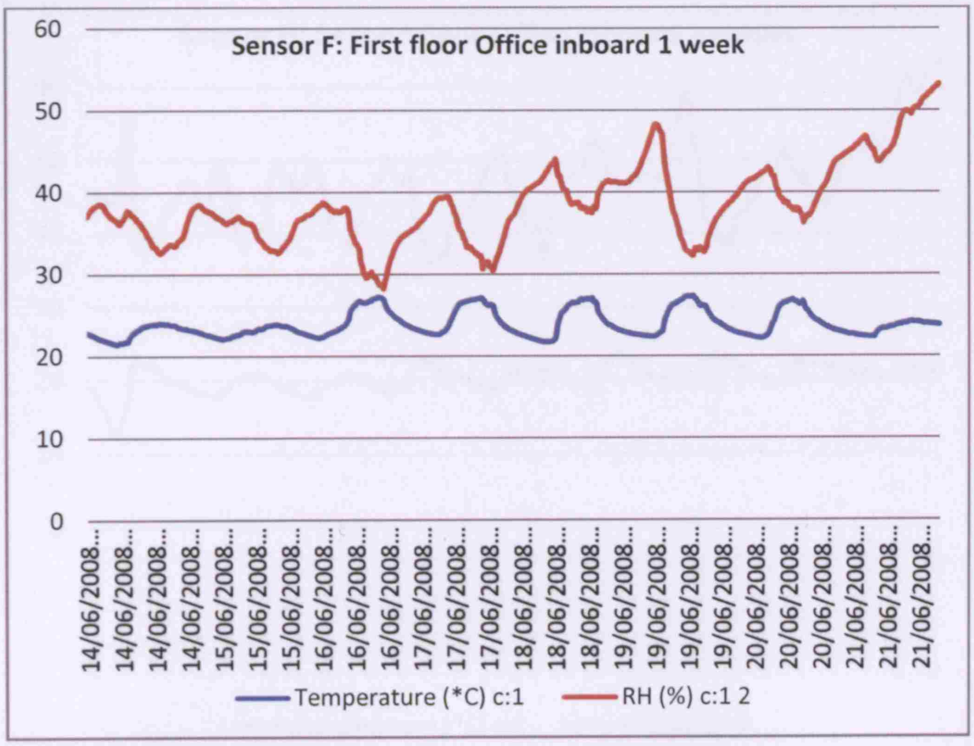
The inboard temperature and RH swings are more extreme 4-5˚C showing the poorer ventilation allowing heat and RH build up. For a summer day the internal temperatures are cool.



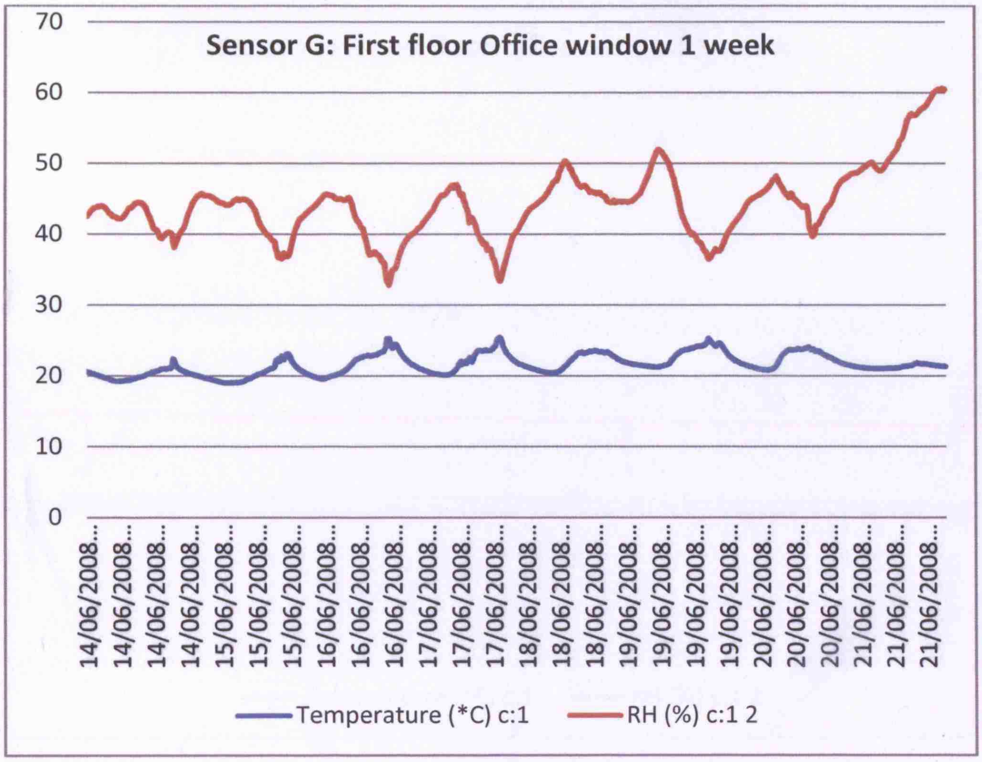
The window side shows less extreme of temperature and RH showing the impact of the better ventilation than inboard. Again it is cool internally for a summer day.



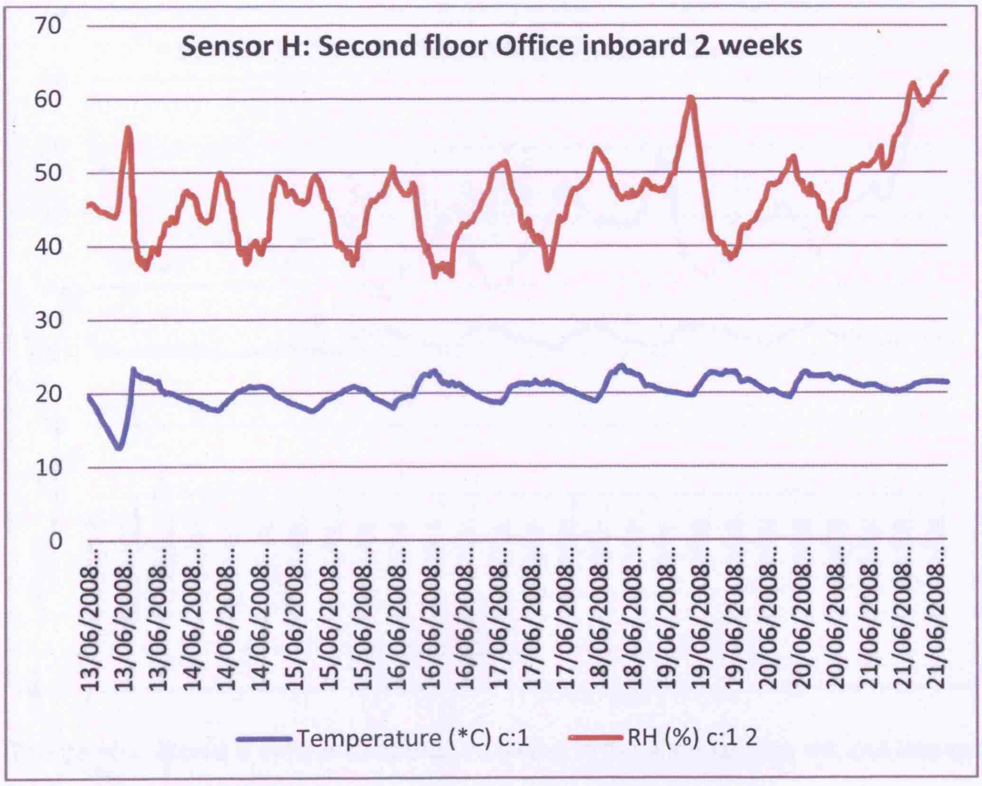
The temperature and RH swing is more extreme than the ground floor the flat tops of the peaks show the cooling working at 25˚C.



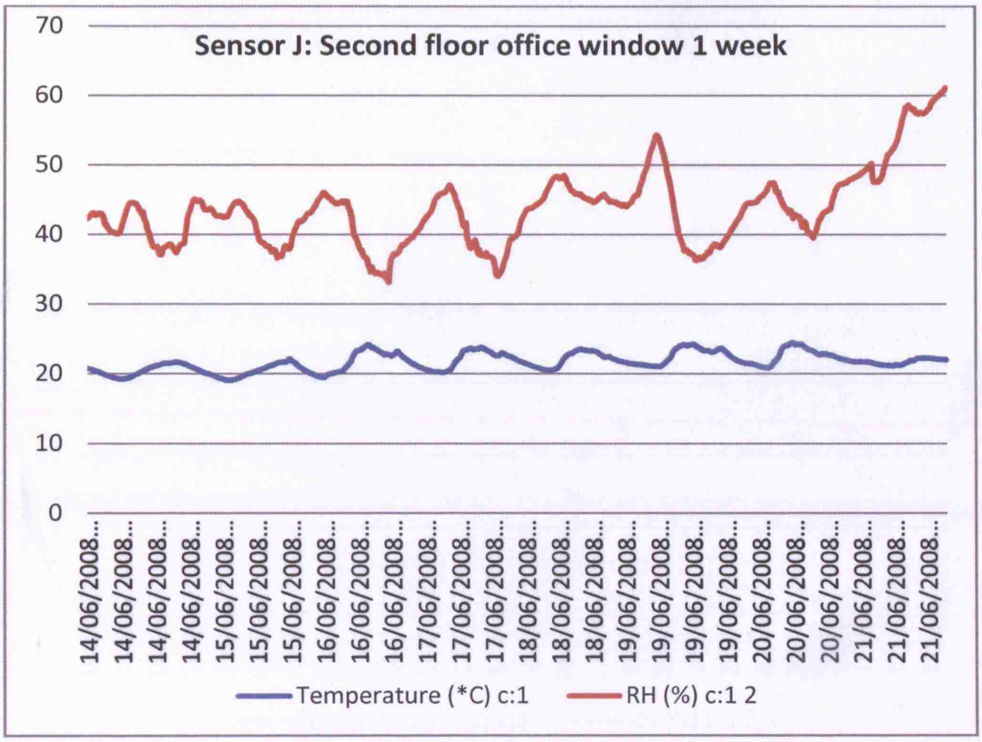
On the sunny side of inboard the temperatures are higher. The cooling has started at 25˚C but it is not coping with the temperature gain inboard.



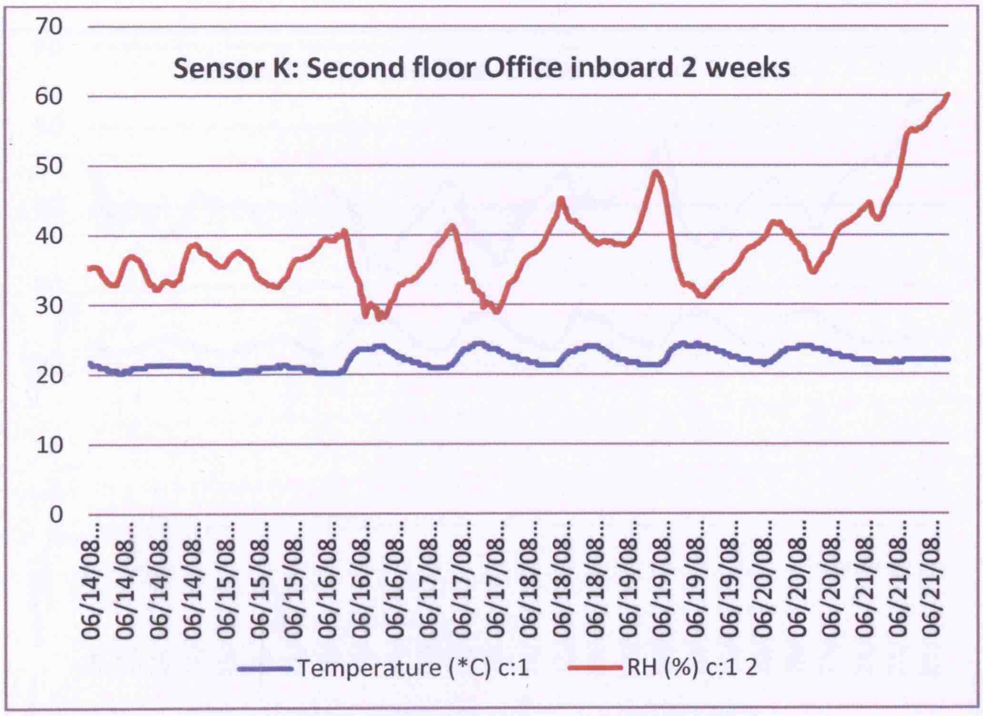
The profile of the peak shows the slight temperature gain late in the day from the sun as is shines on the unprotected on the northwest façade



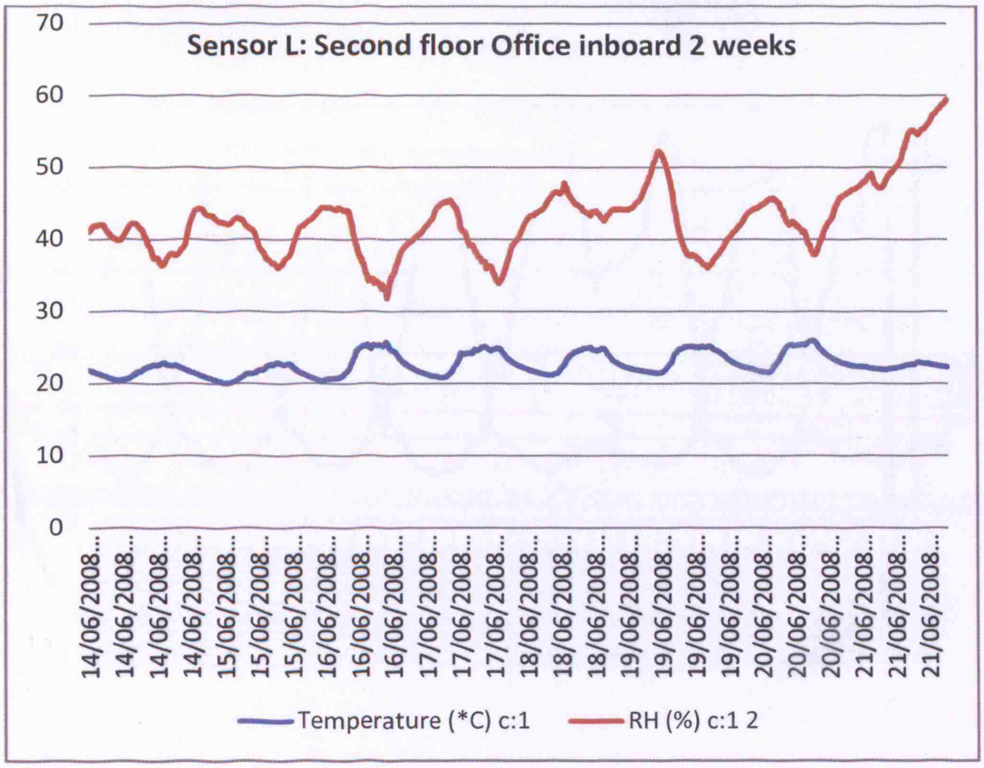
The reading suggest the sensor has been placed on an air input.



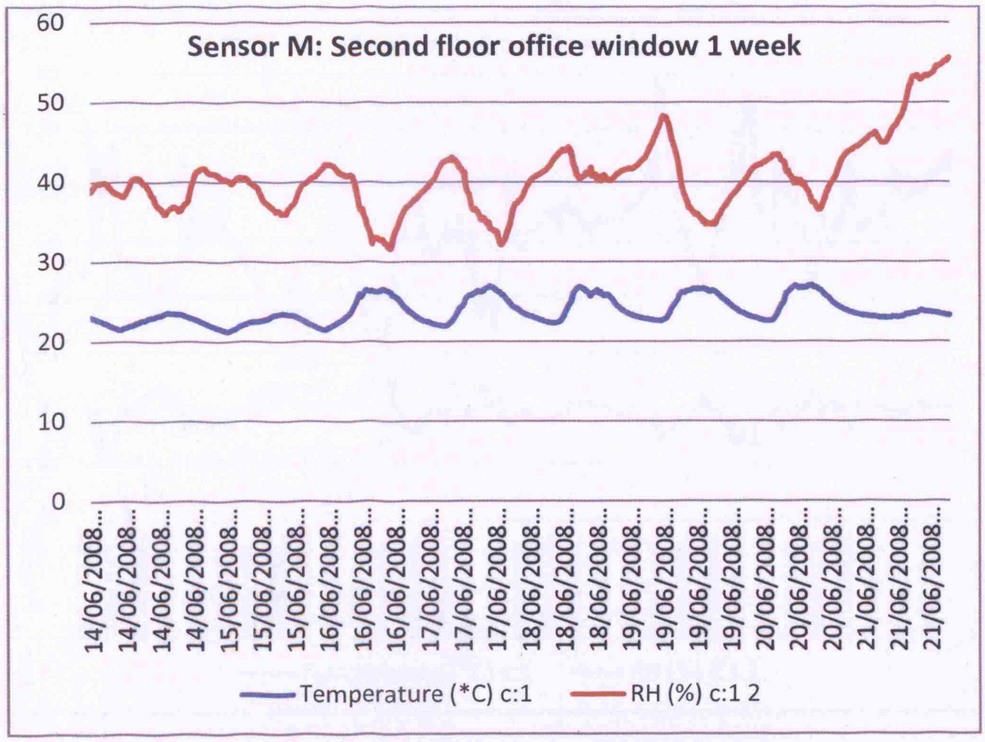
The cooling system has not been needed again the little peak on the back of the slope shows the solar gain late in the day on the unprotected façade.



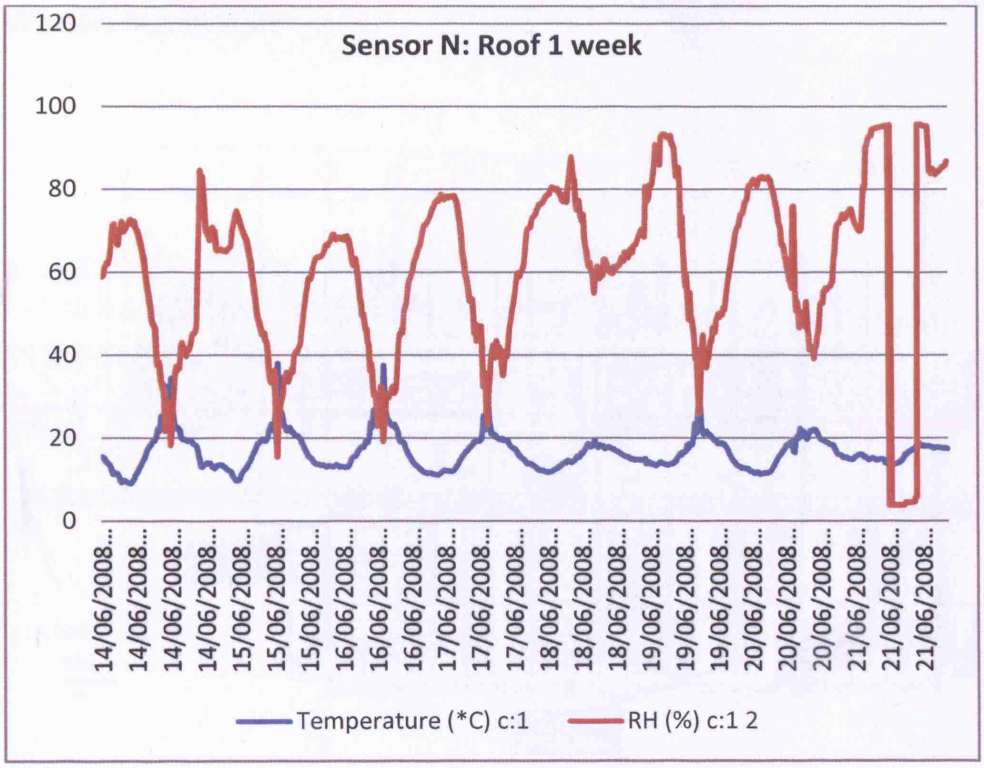
The sensor shows a similar temperature swing to the window side without late solar gain.



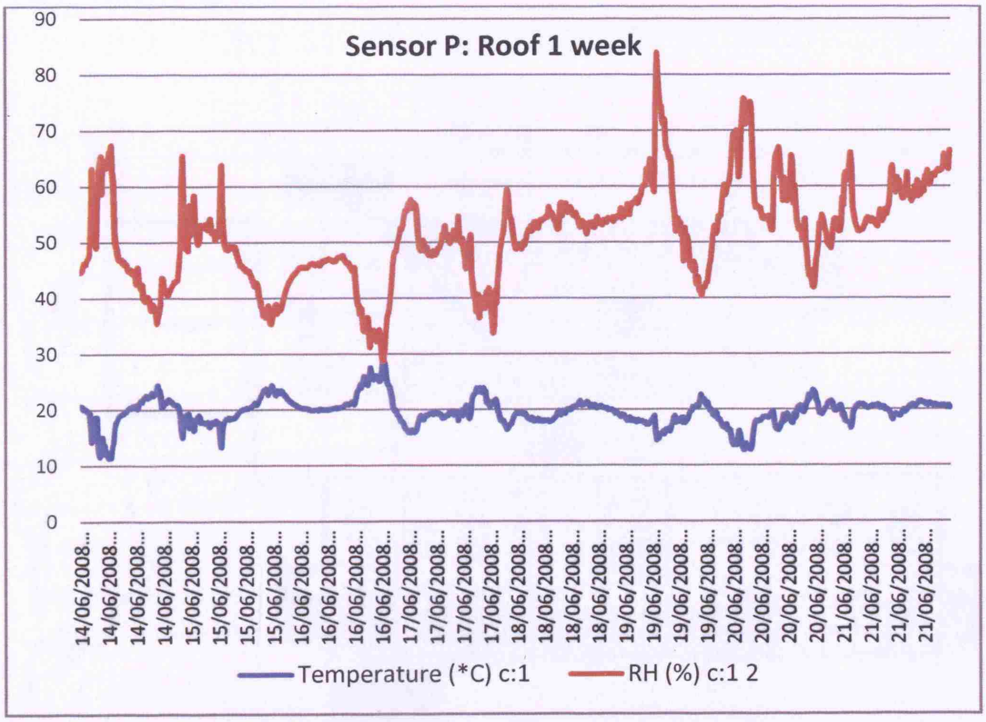
Inboard temperature and RH fluctuation is high pollution from stale air in the lantern may be effecting readings. The flat tops of the peaks show the cooling system working.



The top floor readings inboard and window side are very similar suggesting that the predominant influence of spillage the lantern.

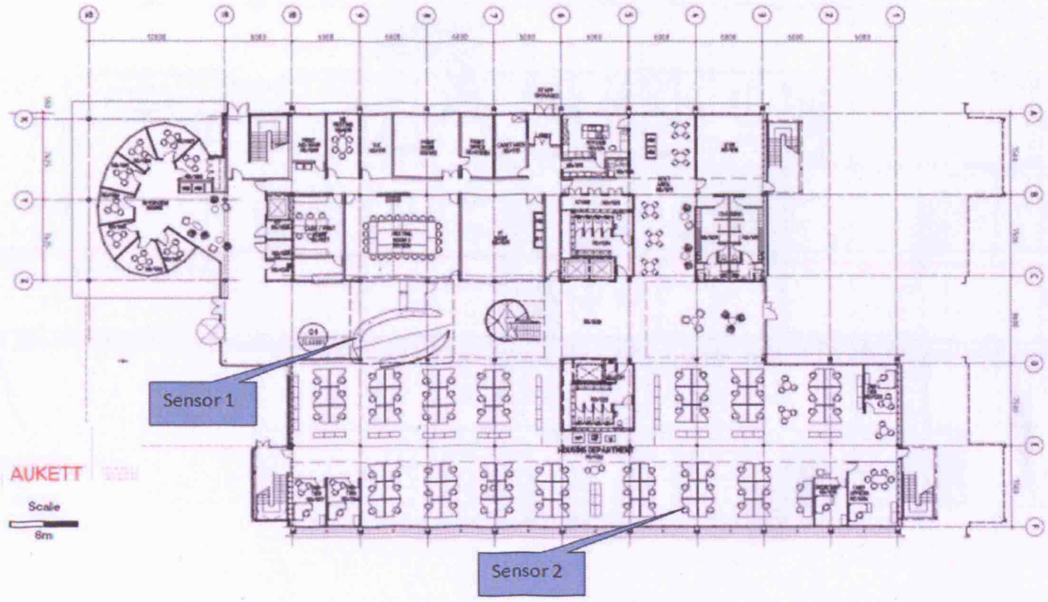


The wild fluctuations reveal the external location. The sensor was sheltered under a roof coping the high spike on the temperature indicates solar gain.

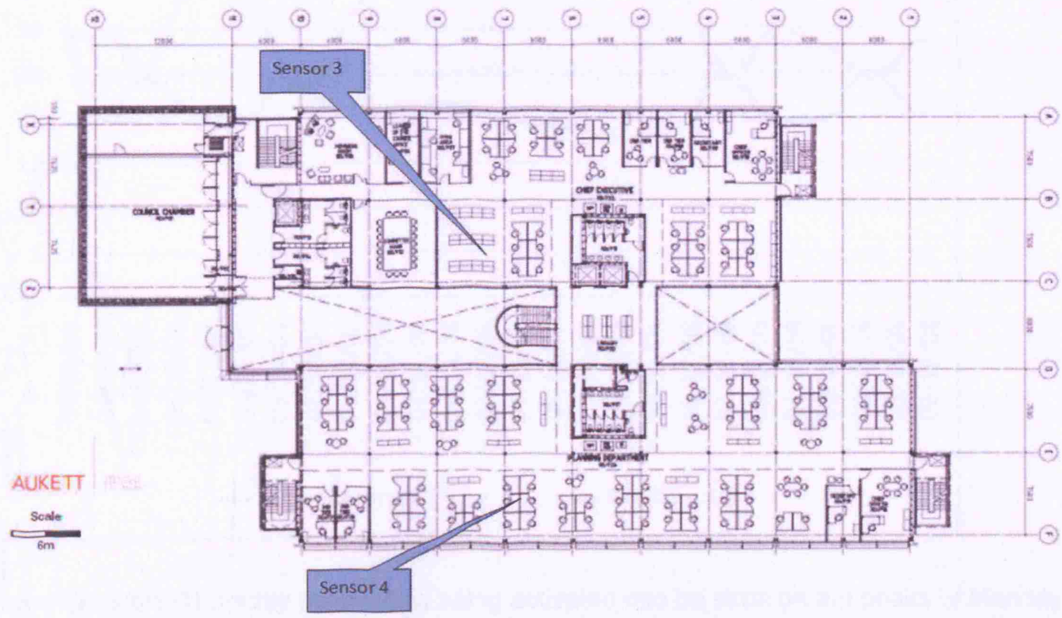


Located in the chiller enclosure which is sheltered but open to the elements the contrast with the other external sensor could not be starker. The enclosure with the heat gain from the chillers has its own microclimate.

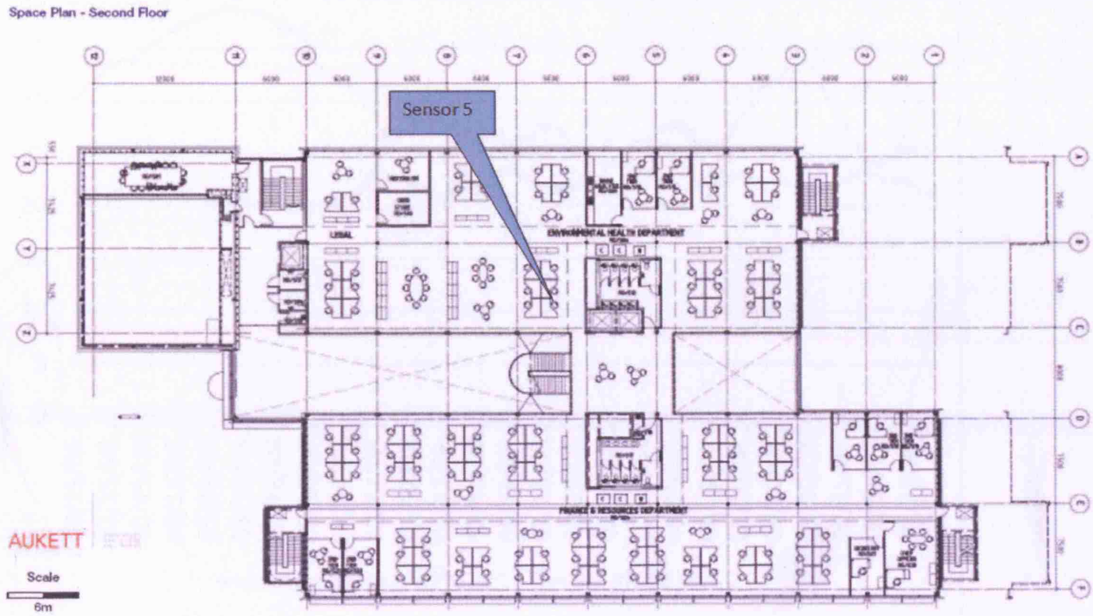
Winter: March 2008



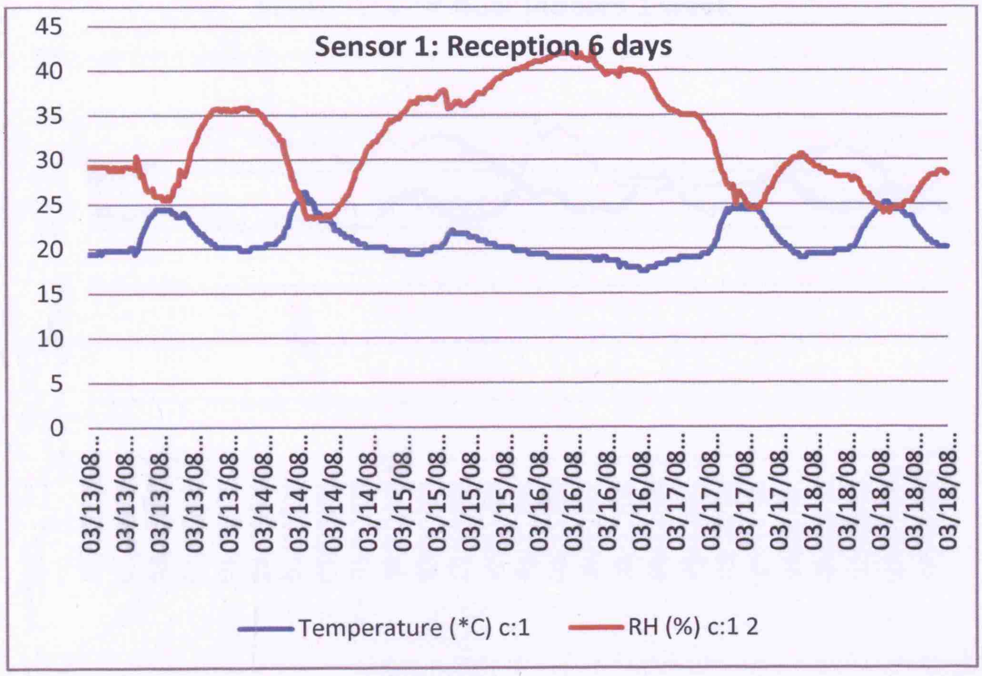
Key Plan: Ground Floor



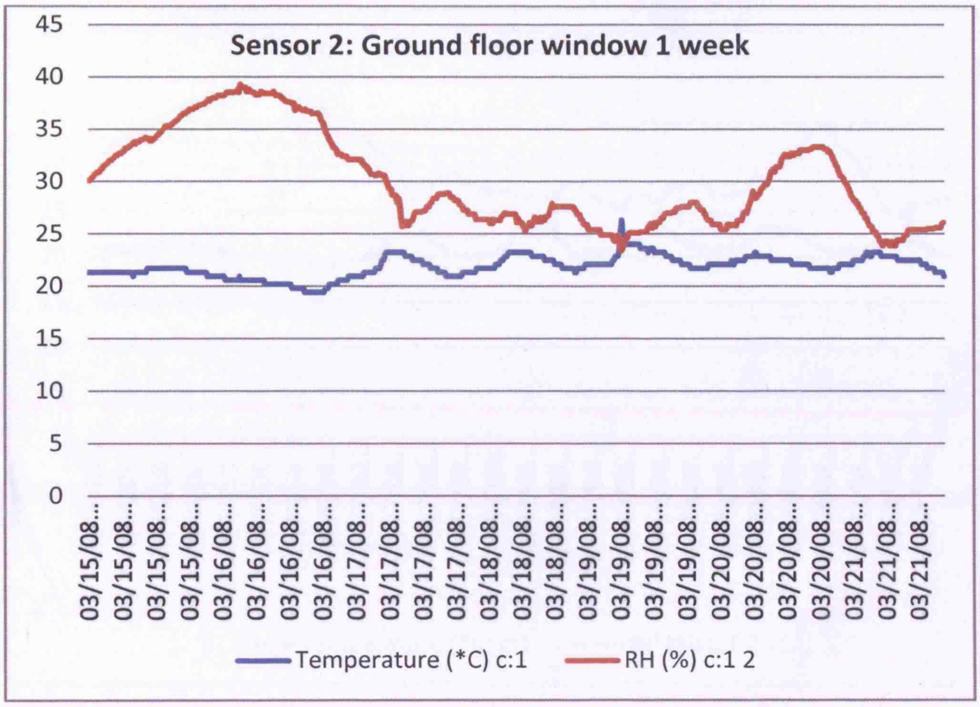
Key Plan: First Floor



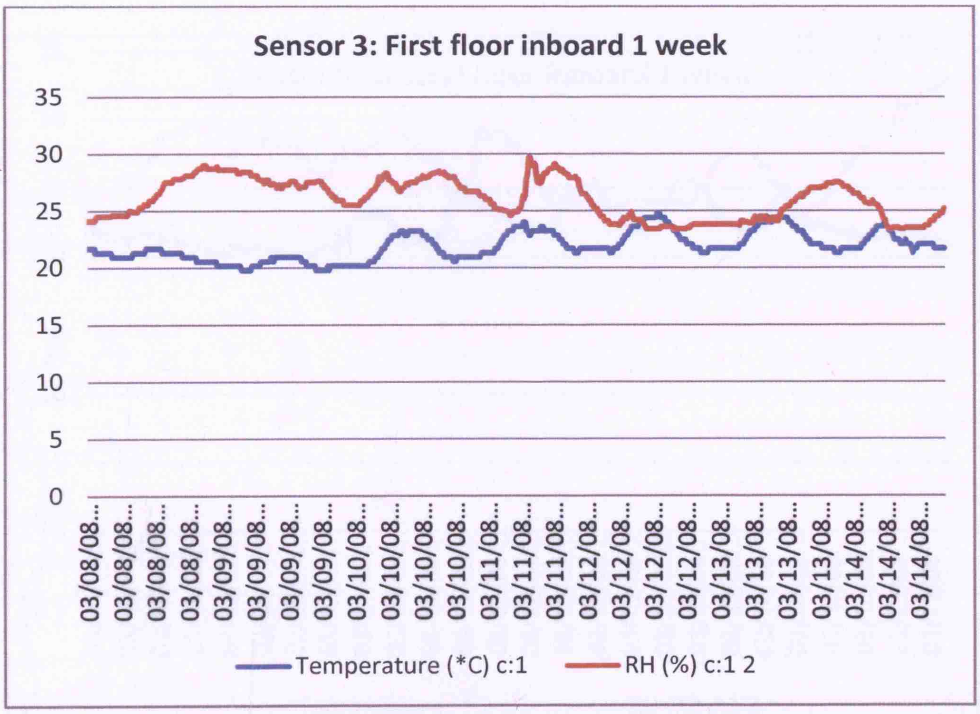
Key Plan: Second Floor



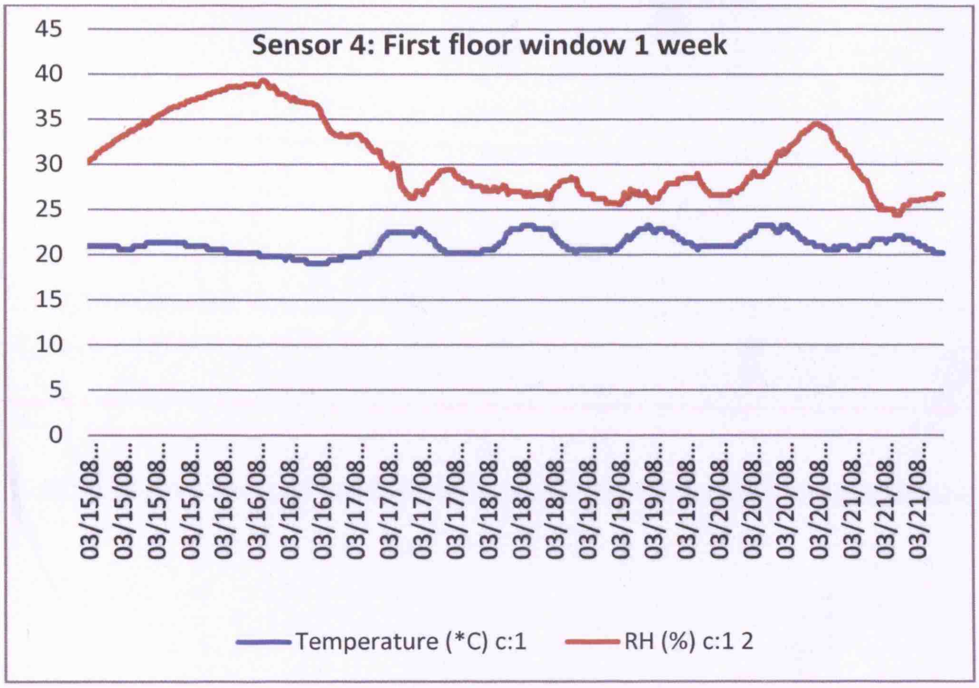
From Thursday-Thursday the cooling being activated can be seen on the peaks of Monday and Thursday. The weekend with no occupants has a steady temperature level but the RH soars. The solar gain from the low sun in winter is evident with the larger temperature swing.



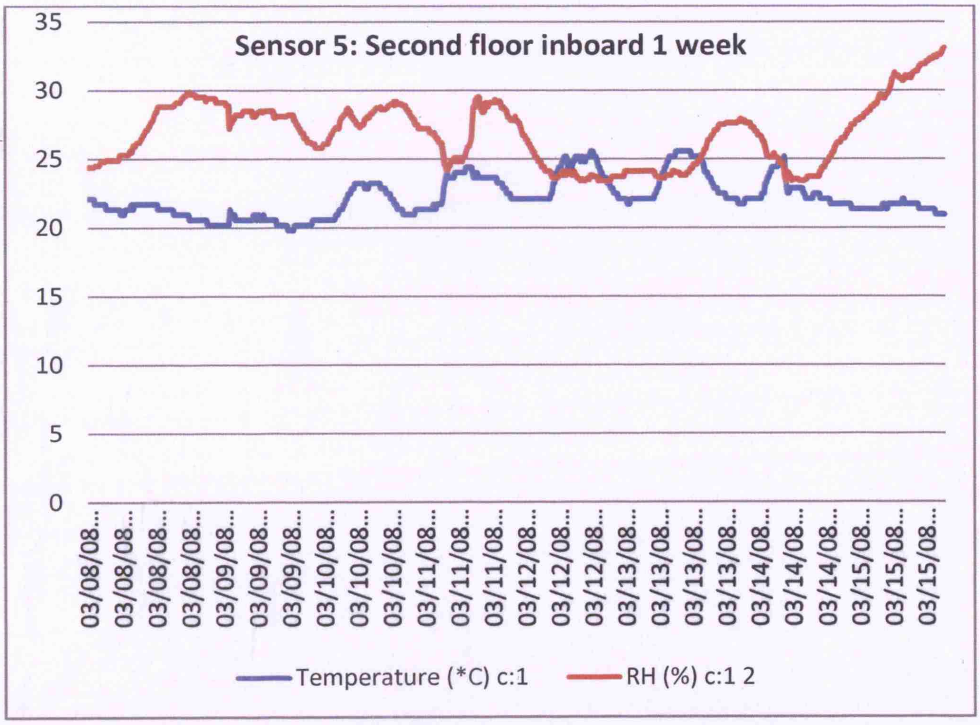
Friday- Friday no idea what caused the temperature spike on Wednesday. The temperature swing over the day is only 3˚C in this location showing the louvres working. RH is too low.



Saterday-Saterday the temperature swings are more extreme inboard in the range of 5˚C. The location will have solar gain from the low sun of the glazed entrance which explains the steep rise in temperature each morning. The flat top to the peak on Monday and Tuesday indicates the cooling working at 23˚C



Saterday-Saterday the temperature swings are more muted than the inboard readings again it looks as though the cooling is working at 23˚C, rather than the designed 25˚C from Monday to Thursday with a distinct flat top to the temperature peak.



Saterday-Saterday a discernable temperature can be seen building up in the week from Monday to Thursday. Again it looks as though the cooling is working on Monday to Tuesday below the correct threshold temperature of 25˚C.